RED-COCKADED WOODPECKER RECOVERY PLAN

1985

RED-COCKADED WOODPECKER RECOVERY PLAN

ENDANGERED SPECIES RECOVERY PLAN

RED-COCKADED WOODPECKER

Picoides borealis

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Prepared by

M. R. Lennartz
USDA Forest Service
Southeastern Forest Experiment Station
Clemson, South Carolina

with assistance from

V. Gary Henry
U.S. Fish and Wildlife Service
Asheville, North Carolina

for

U. S. Fish and Wildlife Service
Region 4
Atlanta, Georgia

Approved: Rolf L. Wallenstrom
Associate Director, U. S. Fish and Wildlife Service

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Informatics General Corporation
6011 Executive Blvd.
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1-800-582-3421

I. INTRODUCTION

A. Description and Taxonomy

The red-cockaded woodpecker (Picoides borealis), one of nine Picoides native to the United States, is easily distinguished from its congeners. The red-cockaded is endemic to the yellow pine forests of the southern United States, and its range overlaps that of only two other members of the genus, the hairy woodpecker (P. villosus) and the downy woodpecker (P. pubescens). Approximately 7-1/4 in. in length, the red-cockaded is slightly smaller than the hairy woodpecker (7-1/2 in.) and considerably larger than the downy woodpecker (5-3/4 in.). The red-cockaded is nearest in size and appearance to the hairy woodpecker, but the two species are easily distinguished. The red-cockaded has a black and white barred back, black-flecked flanks, and black bars on its white outer tail feathers; the hairy is solid white in these areas. The red-cockaded has a larger area of white on its cheeks than the hairy, and a much more narrow band of black running from the eye to the crown separating the white cheek from the white superciliary stripe. While the adult male hairy has relatively large, and quite visible, patches of red on each side of the posterior of its head, the adult male red-cockaded has small red patches of just a few feathers in the same areas, and these small patches or "cockades" are seldom visible in the field. The females of both species lack any red plumage on the head. Because the red cockades of male P. borealis are small and generally concealed beneath the black plumage of the crown, adult males and females are virtually indistinguishable in the field. Nestling and fledgling males, however, are easily distinguished, even in the nest cavity, from the

time they are approximately 15 days old. These juvenile males have a red oval crown patch in the center of their otherwise black crown, and the patch is retained until the first molt in the fall following fledging. At the time the red crown patch is lost, juvenile males acquire the far less prominent red-cockades similar to those of adult males. Jackson (1982) states the males' red crown coloration can often be distinguished at eight days of age before the feathers emerge, but he does not indicate whether or not the observer must have the bird in hand.

B. Ecology and Life History

The red-cockaded woodpecker is endemic to the pine forests of the southern United States. Although its range has become contracted (cf. Jackson 1971, Jackson 1978b), red-cockaded populations are still rather widely distributed. The species is still found in all southern and southeastern coastal states from eastern Texas into southern Virginia, and in the interior small populations are found in southeastern Oklahoma, southern Arkansas, eastern Tennessee, and southeastern Kentucky. Largest populations are in Coastal Plain forests of the Carolinas, Florida, Georgia, Alabama, Mississippi, Louisiana, and eastern Texas, and in Sandhills forests of the Carolinas (Lennartz et al. 1983b).

Breeding biology

The species is nonmigratory and individual families or clans maintain year-round territories around their nesting and roost trees. Red-cockadeds are cooperative breeders with auxilliary or helper birds

aiding a mated pair in the rearing of their offspring (Ligon 1970, 1971, Lennartz and Harlow 1979, and Lennartz 1983). Red-cockaded clans may consist of only a mated pair, a mated pair with their current year's offspring, or a mated pair, their current year's offspring plus helpers. Clan size is generally two to four birds at the beginning of the nesting season and four to six birds after young have fledged (Lennartz 1983). The largest clan the author has observed was nine birds (two parents, three helpers, and four juvenile fledglings). The helpers that aid the breeding pair in rearing offspring are usually male offspring of one or both of the breeders from previous years. Female helpers are extremely rare. In coastal South Carolina, Lennartz (1983) found that in any given year approximately half the clans he studied had helpers, the other half being unassisted pairs. Most clans with helpers (74%) had only one, but some (26%) had two. During one nesting season, one clan was observed with three helpers. Although a resident woodpecker clan may consist of from two to five adult birds during the nesting season, there is only one adult female and one mated pair. In spite of the auxilliary males, there is no evidence that the species is polyandrous.

Murphey (1939) reported red-cockaded nests with eggs from April 3 to May 28 in Florida and indicated the height of the nesting season as April 29 to May 20. Ligon (1970) reported dates of egg laying in Florida as from April 21 to June 4. For South Carolina, Murphey (1939) reported nests with eggs from April 27 to May 28. The author monitored reproductive success of 14-24 clans per year over a period of six years on the Francis Marion National Forest in coastal South Carolina. Dates for clutch initiation of first clutches ranged from April 22 to May 24,

with the majority of clutches being started the last week in April and the first two weeks in May. Dates for initiation of renests ranged from May 22 to June 13, and young were observed in the nest as late as July 6. Jay Carter (per. comm.), commenting on the draft recovery plan, noted he had observed young in the nest as late as August in North Carolina. Murphey (1939) reported clutch size as three to five eggs and Ligon (1970) as two to four. In the author's study area, clutch size ranged from two to four eggs and averaged a fraction over three eggs per nest over a five year period. The incubation period is approximately 10 days (Ligon 1970, Lennartz per. obs.). Ligon (1970) reported young fledging from 26 to 29 days of age, and the author has observed some young fledging as early as 24 days. Ligon (1970) reported one to two fledglings per nest, and indicated he had no evidence that more than two young ever survived to fledging age. In coastal South Carolina, it is not uncommon for as many as three young to fledge, and one clan that had three helpers fledged four young (Lennartz per. obs.). Over a five-year period in coastal South Carolina, the average number of young fledged among clans that nested was 1.8 young per nest per year, and clans with helpers fledged more young per nest than unassisted pairs (2.10 vs. 1.56, Lennartz 1983). Helpers aid parents with incubation and with feeding and brooding nestlings (Ligon 1970, Lennartz and Harlow 1979, and Lennartz 1983), and nestling survival is higher at nests attended by helpers.

Following fledging, juveniles remain in their natal territory through the summer and into the fall. During the late fall, winter, and early spring, juvenile females disperse, but at least some juvenile

males remain with their natal clan and become helpers the following nesting season(s).

Nesting habitat selection

One of the more unique, and certainly the most noted and cited, facets of the red-cockaded's life history is the species' selection of mature, living pines for cavity excavation. While other primary excavators occasionally excavate cavities in living trees, the red-cockaded is the only species to use living trees exclusively. Red-cockadeds have been reported using most species of pine that occur in the South, with the exception of sand pine (Pinus clausa), spruce pine (P. glabra), white pine (P. strobus), and table-mountain pine (P. pungens). Although red-cockadeds will excavate their cavities in several species of southern pines, some observers have suggested that the woodpeckers prefer longleaf (P. palustris) (Lowery 1960 and Baker 1982). Certainly the largest populations of red-cockadeds are found in areas where longleaf pine is prevalent, such as the Sandhills and Coastal Plain physiographic provinces (Lennartz et al. 1983a and Lennartz et al. 1983b).

Regardless of the pine species used, the woodpeckers clearly select older, mature trees for cavity excavation. Red-cockaded cavities have occasionally been found in trees as young as 30-40 years old (Jackson et al. 1979), but the vast majority of cavities are in trees much older. Reported average ages of cavity trees range from 63-176 years for longleaf pine, 70-101 years for loblolly pine (P. taeda), 75-149 years for shortleaf pine (P. echinata), 62-130 years for pond pine (P. serotina), and 70-76 years for slash pine (P. elliottii) (Steirly 1957,

Lay and Russell 1970, Baker 1971, Hopkins and Lynn 1971, Thompson and Baker 1971, Jones and Ott 1973, Grimes 1977, Wood 1977, and Jackson et al. 1979). Red-cockaded cavities have also been found in Virginia (P. virginiana) (Nicholson 1977) and pitch pine (P. rigida) (Mengel 1965), but the age of only one Virginia pine (70 years) was reported. The earliest observers noted that red-cockaded cavity trees were generally infected by the heartwood decaying fungus Phellinus pini (e.g., Murphey 1939), and some have suggested that decayed heartwood must be present for the woodpeckers to excavate their cavities (Steirly 1957, Lay and Russell 1970, and Ligon 1971). Not all red-cockaded cavity trees are infected by heartrot, but there is ample evidence that the woodpeckers tend to select trees with rotten heartwood (Jackson 1977 and Conner and Locke 1982). Heartrot is generally not prevalent in southern pine stands until the trees reach relatively old age (e.g., 100 yrs. for longleaf and 75 years for loblolly) (Wahlenberg 1946 and Wahlenberg 1960), so the propensity of the woodpeckers to select trees with heartrot provides a parsimonious explanation for why cavities are most frequently found in older, mature trees.

Because red-cockadeds will use the same cavity trees for years, or even decades, the age of completed cavity trees may not accurately reflect the age at which trees are selected and excavation begun. Jackson et al. (1979) reported ages for just start trees (trees with new cavity excavations) from two study sites, one in Mississippi, the other in South Carolina. Average ages for loblolly start trees were 74 and 77 years, longleaf starts averaged 95 years, and pond pine starts averaged 85 years. The majority of loblolly start trees were over 70 years old, and the majority of longleaf over 80 years.

The cavity trees used by a clan of woodpeckers tend to be clustered in small groups that have been termed colonies or colony sites (Lay and Russell 1970 and Jackson and Thompson 1971). Individual colonies may have from one to 30 cavity trees (Jackson 1977) including trees with completed, active cavities, trees with cavities being excavated (start holes), and trees with inactive and abandoned cavities which frequently are occupied by competitors (Dennis 1971, Jackson 1978a, and Harlow and Lennartz 1983). Within colonies, individual trees may be as far as 2,400 feet apart, but in most colonies the trees are clumped within an area that can be encompassed by a circle 1,500 feet in diameter (Harlow et al. 1983).

Most active colonies are found in open, park-like stands of pine with sparse midstories (Lay and Russell 1970, Ligon 1970, Beckett 1971, Hopkins and Lynn 1971, Morse 1972, and Jones and Ott 1973). In studies where stand conditions have been described in quantitative terms, stocking levels in stands with active woodpecker colonies have ranged from 10 to 150 ft^2 of basal area per acre (Lay and Russell 1970, Hopkins and Lynn 1971, Thompson and Baker 1971, Grimes 1977, and Locke 1980). While it appears that the woodpeckers accept a rather wide range of stocking in the pine overstory, most authorities feel the birds will not tolerate dense hardwood stocking in midstory. Beckett (1971) was the first to suggest that red-cockaded woodpeckers would abandon their cavities if the understory reached the height of the entrance. Most biologists accept this opinion, and Jackson (1978a) has suggested one plausible explanation. Pine stands on moist sites with well developed hardwood midstories seem to provide better habitat for pileated

woodpeckers (Dryocopus pileatus) and red-bellied woodpeckers (Melanerpes carolinus) than do more open stands of pure pine on drier sites. Both woodpeckers are notorious for enlarging and usurping red-cockaded cavities. Thus, interspecific competition may be one reason why active red-cockaded cavities are seldom found or seldom persist in stands of mixed pine-hardwood, or in pine stands with well developed hardwood midstories. The few studies which have quantified hardwood stocking levels in colony stands indicate that at active colony sites, hardwood stocking is generally below 35 ft^2/acre of basal area and generally less than 35% of total stand stocking (Grimes 1977, Van Balen and Doerr 1978, Locke 1980, and Lennartz et al. 1983a). Average hardwood stocking was 20 ft^2/acre or lower and less than 14% of total stand stocking.

Foraging habitat selection

Throughout their range, red-cockaded woodpeckers exhibit a distinct preference for living pines as a foraging substrate (e.g., Florida, DeLotelle et al. 1983a, Labisky and Porter 1984, Ligon 1968, Nesbitt et al. 1978, and Patterson and Robertson 1981; Louisiana, Morse 1972; Oklahoma, Wood 1977; Virginia, Miller 1978; Mississippi, Ramey 1980; and South Carolina, Hooper and Lennartz 1981, Ramey 1980, and Skorupa 1979). Although pines are clearly preferred, other species are also foraged upon. Most of the investigators cited above reported some use of hardwoods as foraging sites. The greatest reported use of hardwood trees was 22% by males in Mississippi (Ramey 1980). Red-cockadeds will also forage on cypress (DeLotelle et al. 1983a, Hooper and Lennartz 1981, Ramey 1980), but in South Carolina Hooper and Lennartz (1981) concluded that the use of cypress could be related to low availability

of pine. In Florida, DeLotelle et al. (1983a) considered cypress domes important foraging habitats, yet they reported that the 5 clans studied spent 90% of their foraging time in pines. They also noted that in terms of stem size and density, the pine stands in their study area were of relatively poor quality. Consequently, the use of cypress may again have been related to low availability of pine.

In addition to exhibiting a preference for pines, red-cockadeds also select larger pines over smaller pines as foraging sites. In South Carolina (Hooper and Lennartz 1981 and Skorupa 1979), investigators found that red-cockaded use of pine trees ≥ 10 in. dbh greatly exceeded their availability. Similar observations were reported by DeLotelle et al. (1983a) in Florida, though on their study site trees tended to be smaller on the average than in South Carolina, and the woodpeckers there made much greater use of smaller pines than at the South Carolina sites. At another study site in Florida, Labisky and Porter (1984) also reported that red-cockadeds selected trees of greater average diameter and height than the average trees available.

The preference for pine as a foraging substrate is further reflected in the relative use of various forest types and individual stands selected as foraging habitat. In Florida, Nesbitt et al. (1978) reported that 3 clans of red-cockadeds spent 94% of their time foraging in pine habitats. Two habitat types, pond-slash pine flatwoods and slash pine plantation, were used more than their proportional acreage within the three home ranges; two habitat types, longleaf pine flatwoods and bayhead-pond borders and cypress domes, were used less than their proportional acreage; and two nonforest habitats were not used for

foraging. In north Florida (Labisky and Porter 1984), stand selection by red-cockadeds was related to both forest type and average tree size. Ninety-nine percent of all foraging observations were recorded in either longleaf or slash pine stands, longleaf was selected over slash, and stands with mean tree height > 65 ft. and mean tree diameter > 8 in. dbh were used in greater proportion than their availability. Ramey (1980) reported on foraging habitat selection in both Mississippi and South Carolina, though no data were provided to compare use to availability. In South Carolina, she found that 3 clans spent the majority of their time (61%) in pine dominated habitats (pine and pine-hardwood stands) and 35% of their time in hardwood-pine stands. In Mississippi, the majority (63%) of foraging observations were also in pine dominated habitats. In both study areas, even when the woodpeckers foraged in hardwood dominated habitats (hardwood-pine and hardwood), the majority (71% in Mississippi and 96% in South Carolina) of foraging observations were on pine trees. In Oklahoma, Wood (1983) reported that the portion of one home range that was used most intensively for foraging by red-cockadeds had the highest pine density and lowest hardwood density.

The foraging behavior and home range studies by Hooper and Lennartz (1981) and Hooper et al. (1982) also provided data for examining forest stand selection by foraging red-cockadeds (Hooper and Harlow in prep.). Foraging time relative to stand size was calculated as a measure of habitat preference for 272 stands within 18 year-round home ranges in coastal South Carolina. The 272 stands were grouped into 13 forest stand or habitat types based on size and stocking of pines and the basal area of hardwoods. Stands of large and small pine sawtimber and pine

seedtree stands had the highest selection or preference ratios (use/availability ratio > 1.0). Pine pole, pine-hardwood sawtimber, and hardwood-pine sawtimber were used at a rate equal to their availability. Except for pine seedling stands, some use was made of all other forest stand types (hardwood-pine pole, hardwood sawtimber, pine sapling, hardwood pole, and cypress pole), but use was less than expected based on availability. Cypress sawtimber stands had high selection ratios, but this was recorded in only two home ranges and appeared to be related to low availability of pine. Across all home ranges and stand types, 92% of the foraging observations were in pine dominated stand types or habitats. Among all stand types, stand selection was positively related to density of pine stems ≥ 10 in. dbh and inversely related to the stocking of hardwoods ≥ 5 in. dbh. Preference (use/availability ratio > 1.0) was exhibited for stands with more than 24 pines per acre ≥ 10 in. dbh and with less than 43 ft^2/acre of hardwood basal area. Among pine stands, selection was related to stand age. Foraging preference increased sharply with stand age up to 30 years. For stands over 30 years, preference values fluctuated among 10-year age groups, but appeared to gradually increase with age.

These various studies from throughout the species' range clearly demonstrate the red-cockaded's strong preference for pine trees as a foraging substrate and pine dominated stands for foraging habitat. Where use has been related to availability on a stand basis, investigators have measured different parameters and identified preferred habitats in different terms. In South Carolina, Hooper and Harlow (in prep.) considered well-stocked pine and pine-hardwood stands,

with ≥ 50% of their basal area in pine, with more than 24 stems per acre ≥ 10 in. dbh, and 30 years of age or older to be preferred habitat. In Florida, Labisky and Porter (1984) considered stands with average tree diameter > 8 in. dbh and mean tree height > 65 ft. to be preferred habitat.

Despite numerous home range studies, few studies have attempted to define the amount of foraging habitat required to support a clan of woodpeckers. Red-cockaded clans maintain a year-round home range that surrounds their colony sites. The woodpecker is territorial and defends its home range from adjacent clans (Ligon 1970, Lay et al. 1971, Nesbitt et al. 1978, Sherrill and Case 1980, Hooper et al. 1982, DeLotelle et al. 1983b). Seven studies reported 22 seasonal ranges (total area traveled) of 18 clans. These seasonal ranges varied from 35 acres to 526 acres and averaged 162 acres (Baker 1971, Crosby 1971, Skorupa and McFarlane 1976, Nesbitt et al. 1978, Sherrill and Case 1980, Nesbitt et al. 1983, Wood 1983). One year-round home range from south Florida was 393 acres (Patterson and Robertson 1981). Hooper et al. (1982) found 24 year-round home ranges (total area traveled less extra territorial and limited use areas) in South Carolina varied from 74 to 482 acres and averaged 174 acres. The total area traveled by the South Carolina clans varied from 84 to 556 acres and averaged 215 acres. In central Florida, DeLotelle et al. (1983a) found 4 year-round ranges (total area traveled) varied from 287 to 491 acres and averaged 366 acres. In north Florida, Labisky and Porter (1984) found 4 year-round home ranges (measured by the harmonic-mean measure of animal activity) ranged from 210 to 388 acres and averaged 319 acres.

Home range size is informative, but it does not describe the amount of foraging habitat used or required by a clan of woodpeckers. Red-cockaded home ranges generally encompass forest types and stand conditions in which the birds do little or no foraging. And without territorial constraints, red-cockadeds roam over extensive area that they may or may not need to meet their foraging requirements. In addition, studies have indicated that home range size is related to population density. Sherrill and Case (1980) found a positive relationship between size of red-cockaded home ranges and mean distance to nest trees of surrounding clans. Hooper et al. (1982) found that population density relative to available habitat accounted for 70% of the variation in size of year-round home ranges. They concluded that home range size was primarily a result of the clans in an area dividing up the amount of available habitat. DeLotelle et al. (1983b) also noted that home range size appeared to be greatly influenced by proximity to other colonies. On the other hand, large home ranges may also result from sparse foraging resources. Consequently, foraging habitat requirements can best be inferred from those home range studies that incorporate habitat selection, population density, and clan performance in the study design.

Nesbitt et al. (1978) and Nesbitt et al. (1983) reported seasonal range size (total area traveled) and habitat utilization for red-cockadeds in two study areas in Florida. In northcentral Florida, 3 red-cockaded clans were observed to have ranges of 144 to 226 acres, averaging 172 acres. These ranges encompassed 122 to 197 acres of foraging habitat, averaging 150 acres. In southwest Florida, 5

woodpecker clans used ranges of 193 to 527 acres that averaged 357 acres. These ranges encompassed 109 to 200 acres of pine foraging habitat and averaged 152 acres. The year-round home ranges reported on by DeLotelle et al. (1983a) in central Florida and discussed above (n = 4, range = 287 to 491 acres, $\overline{X}$ = 366 acres) encompassed 287 to 439 acres of pine and cypress foraging habitat and averaged 344 acres of foraging habitat. And in north Florida, the year-round ranges monitored by Labisky and Porter (1984) (n = 4, range = 210 to 388 acres, $\overline{X}$ = 319 acres) encompassed 195 to 269 acres of pine habitats, of which an average of 203 acres was utilized for foraging. The 24 year-round home ranges in coastal South Carolina reported on by Hooper et al. (1982) averaged 174 acres. Eighteen of these home ranges on the Francis Marion National Forest, for which the most complete habitat data was available, averaged 139 acres of good foraging habitat (well-stocked pine and pine-hardwood stands, 30 years of age and older). As noted earlier, Hooper et al. (1982) found that population density accounted for 70% of the variation in size of the year-round home ranges. When the largest home range (482 A) which had no territorial constraints was excluded from the calculations, the average amount of foraging habitat per clan was 126 acres.

The most meaningful way to determine the amount of habitat needed by red-cockadeds is to examine the performance of clans with various amounts of foraging habitat available to them. In an unpublished analysis, Hooper and Lennartz (per. comm.) examined the performance of clans relative to the foraging resources used in the 18 year-round home ranges on the Francis Marion National Forest. Three criteria were used

in evaluating clan performance: (1) long term occupancy of home ranges and colony sites, (2) clan reproduction, and (3) clan size.

All 18 home ranges were occupied by red-cockaded clans for at least 10 years. For the nesting season during which home range determination began, there was a positive correlation between the amount of foraging habitat used and the number of young fledged ($r^2 = 0.3817$, $p \leq 0.0063$). No correlation was found between area of foraging habitat and clan size. Clans with helpers had significantly larger home ranges during the nesting season than clans with just a pair ($p \leq 0.05$, Wilcoxon 2-sample test), but there was no significant difference in area of foraging habitat either during the nesting season or year round ($p > 0.17$ and $p > 0.79$) between clans with and without helpers. For the nesting season immediately following home range determination, no significant correlation was found between the number of young fledged and the amount of foraging habitat used the previous year.

For the year in which there was a significant correlation between area of foraging habitat and number of young fledged, the data set was divided into three groups representing clans that used low, average, and high amounts of foraging habitat. Clans ($n = 6$) with 50-99 acres of foraging habitat averaged 1.0 young fledged, clans ($n = 6$) with 100-149 acres of habitat averaged 2.16 young fledged, and clans with ≥ 150 acres of foraging habitat averaged 2.67 young fledged. The relationship between higher reproduction and increasing amounts of habitat is apparent, with the most dramatic increase occuring when going from 50-99 acres up to 100-149 acres (116% increase). The increase in young fledged in going from 100-149 acres up to ≥ 150 acres was relatively

small (24%), and much of that difference was due to one clan which had 3 helpers and fledged 4 young. A clan with 3 helpers is extremely rare (Lennartz 1983). The next year that clan did not nest at all and the next 3 years fledged an average of 2.0 young per year. The clan also had 153 acres of habitat, almost placing it in the middle group (100-149 acres of habitat). Thus, if reproduction is recalculated after dropping data from this clan, the remaining clans with ≥ 150 acres of habitat fledged 2.4 young. Either excluding the one clan with 3 helpers or not excluding it, the number of young fledged in the clans with 100-149 acres of habitat were very similar to those in clans with ≥ 150 acres of foraging habitat.

Based on these analyses, Hooper and Lennartz (per. comm.) concluded that 125 acres of well-stocked pine and pine-hardwood stands, 30 years of age and older, would provide adequate foraging resources for the survival and productivity of a clan of woodpeckers. (The 125 acres represents the midpoint of 100-149 acres class used in the reproduction analysis, as well as the mean acreage of foraging habitat from the 17 home ranges with territorial constraints). Some important emphases are that the home ranges from which this conclusion was drawn had a considerable amount of older and larger pines; 40% of the foraging habitat among all home ranges was ≥ 60 years old. Thus, to correspond to those conditions, 50 of the 125 acres should be 60 years of age or older. In addition, 94% of the foraging habitat was within 0.5 miles of the colony, so the 125 acres of habitat should be within that distance of the colony. Meeting these criteria provides a substantial amount of preferred foraging habitat capable of sustaining a productive clan of

red-cockaded woodpeckers. Significant additional amounts of acceptable foraging resources will also be provided incidentally within home ranges by noncommercial habitats, commercial hardwood-pine and hardwood stands, young pine stands (i.e., ≤ 30 years old), and pine stems intermixed in mesic forest types along streams, drains, and pond margins.

A critical comparison of the various studies of red-cockaded foraging behavior and foraging habitat selection indicates that the foraging habitat recommendations derived by Hooper and Lennartz for South Carolina would be applicable in other parts of the woodpecker's range. In coastal South Carolina, foraging habitats were well stocked, with 60-90 ft^2/acre basal area of pine ≥ 5 in. dbh. In southwest Florida, where Nesbitt et al. (1983) reported clans using slightly more pine foraging habitat (152 acres), the pine trees had "comparatively small dbh's" and stands had only a 20-30 ft^2/acre BA of pine. In central Florida, DeLotelle et al. (1983a) reported clans using much larger areas of foraging habitat (344 acres), but their home ranges averaged only a 10 ft^2/acre BA of pine. Consequently, the home ranges in central and south Florida were supporting red-cockaded clans with approximately 40% of the total pine basal area found in the 125A recommended by Hooper and Lennartz.

In north Florida, the woodpecker clans monitored by Labisky and Porter (1984) had a wider range of pine habitats available than on the other study areas in Florida, but they still averaged 203 acres of foraging habitat. Again, however, the home ranges were dominated by relatively young stands of small average diameter. This suggests that the low quality of the general foraging habitat influenced the acreage

of habitat used. "Preferred" habitat, which accounted for 65% of the foraging observations (R. F. Labisky, per. comm.) was similar in terms of stocking, density, and average diameter to stands identified as "preferred" by Hooper and Harlow (in prep.) on their study area in South Carolina. In north Florida, however, the home ranges averaged only 101 acres of preferred habitats, and the preferred habitats were distributed in "relatively small habitat islands" (Labisky and Porter 1984). Consequently, red-cockadeds traversed larger areas and foraged in the larger trees in younger stands to supplement the low availability of preferred stands. These supplemental areas, termed "avoided with selection" by the investigators, had an average age of 34 years, an average stem diameter (by basal area) of 5.7 in. dbh and included stands as young as 11 yrs. old. Pine stands this young and with average diameters this small would be expected to have very few stems of the size preferred by red-cockadeds (≥ 10 in. dbh) (cf., USDA 1976, Table 163, p. 185). Consistent with the low availability of preferred foraging substrate, supplemental foraging areas were relatively large, averaging 101 acres. By comparison, only 25 acres of pine and pine-hardwood stands identified as preferred habitat by Hooper and Lennartz would have provided as much preferred foraging substrate (cf., USDA 1976, Table 163, p. 185) as the 101 acres of supplemental habitat in Florida.

Thus, when one critically examines the data from both South Carolina and Florida in terms of foraging substrate preference and foraging substrate availability, rather than simply in terms of area, the conclusion is that 125 acres of well-stocked (60-90 ft^2/acre BA),

pine and pine-hardwood stands (≥ 50% BA in pine) 30 years of age and older (40% ≥ 60 yrs. old) with 24 pines per acre ≥ 10 in. dbh will provide ample foraging substrate to sustain viable red-cockaded woodpecker clans. Emphasizing preferred foraging habitat in management programs assures that red-cockaded clans will be provided ample foraging resources within a reasonable distance of colony sites. And when preferred habitats are prescribed in management programs, substantial additional acreage of "supplemental" habitats (e.g., pine stands 10-30 yrs. old) will be provided incidentally. On areas with younger, smaller diameter, or more sparsely stocked pine habitats, where preferred habitat cannot be provided immediately, larger acreages of foraging habitat would be required to provide equivalent amounts of foraging substrate. The 125 acres of preferred foraging habitats in the South Carolina home ranges contained an average of 21,250 pine stems with a total basal area of 8,490 ft^2 and 6,350 pine stems ≥ 10 in. dbh. The acreage required to provide equivalent amounts of foraging substrate on forests with stands of different age and stocking can be developed with knowledge of local stand conditions and reference to local or regional stand tables (e.g., Schumacher and Coile 1960 and USDA 1976). The acreage equivalent developed should be based on the foraging habitat requirement (e.g., pine density, pine basal area, or density of larger stems) most lacking in the local area.

C. Historic Perspectives

Historic records provide neither precise nor quantitative information for assessing how large red-cockaded woodpecker populations may once have been. All available evidence, however, suggests that

historically the woodpecker was far more abundant and widely distributed than today. In the early nineteenth century, Audubon (1839) stated that red-cockadeds were "found abundantly from Texas to New Jersey and as far inland as Tennessee." He also noted that the red-cockaded was most abundant in the pine barrens of Florida, Georgia, and South Carolina. A century or so later, ornithologists still considered the red-cockaded "locally common" in Florida (Howell 1932), Georgia (Greene et al. 1945), South Carolina (Sprunt and Chamberlain 1949), and Louisiana (Lowery 1960). About the same time, however, population declines and loss of habitat were being noted and concern expressed for the species' survival (e.g., Murphey 1939, Sprunt and Chamberlain 1949, Sprunt 1954, Steirly 1957, Pearson et al. 1942, and Burleigh 1958). Terms such as "abundant," "common," or "locally common" are subjective and open to varying interpretations. There seems to be an important contrast, however, between Audubon's (1839) statement of widespread abundance and statements a century later of only locally common. This contrast seems to imply both a decline in the rangewide population of red-cockaded woodpeckers and the fragmentation of the population into more local units. This inference agrees with Jackson's (1971 and 1978b) more thorough and quantitative analysis which documents both a contraction in the red-cockaded's range and an increasing fragmentation of the total population.

A major decline in red-cockaded populations and the reason for the decline can also be presumed from forestry records. In the mid-1900's, Wahlenberg (1946) noted that longleaf pine forests which had covered extensive areas from North Carolina into eastern Texas had been reduced

to only one-third to one-half their original area. Loblolly pine forests which once occupied an estimated 96 million acres had shrunk to 53 million acres (Wahlenberg 1960). The red-cockaded's association with pine forests has been voluminously documented. There can be no doubt that red-cockaded woodpecker populations declined dramatically as pine habitats disappeared.

D. Current Status

The red-cockaded woodpecker was placed on the Federal list of endangered species in 1970. The reasons for the woodpecker's classification as endangered were its perceived rarity, documented declines in local populations, and presumed reductions in available nesting habitat. Although professional opinion was widely solicited to make an objective assessment of the woodpecker's status, much of the information provided was anecdotal. No censuses had been conducted, and no estimates were available of the probable size of regional or local populations nor of availability and trends of nesting habitat.

Red-cockaded woodpecker populations

The red-cockaded's endangered status stimulated increased research efforts on this species. A symposium on the woodpecker's ecology and management (Thompson 1971) was held in 1971, and Jackson (1971) provided the first estimate of the red-cockaded's rangewide population based on a review of the literature and on information he solicited from investigators studying the bird. Jackson's preliminary estimate was that the total population of red-cockaded woodpeckers was 2,939 birds, but he judged this estimate as conservative. He suggested the total

population could be two to three times larger but probably not as large as 10,000 birds. Jackson (1978b) subsequently refined his preliminary population estimate based on additional literature and museum records, recently completed studies, and a questionnaire survey he conducted among state and federal conservation agencies, private conservation organizations, forest industries, and interested individuals throughout the southeastern United States. Based on his survey efforts, Jackson estimated the total red-cockaded population to be between 1,500 and 3,500 colonies and 4,500 to 10,500 birds. In addition to Jackson's rangewide population estimate, there have been a few population estimates developed for individual states (e.g., Wood 1977, Jackson et al. 1976, Nicholson 1977, Miller 1978, Baker et al. 1980, Baker 1982, and Carter et al. 1983). All state estimates, except that of Baker et al. (1980) for Florida, Baker (1982) for Georgia, and Carter et al. (1983) for North Carolina were included by Jackson (1978b) in his total estimate.

These various surveys provided important information on the relative size and distribution of selected red-cockaded populations, but they did not provide the bases for developing statistically valid population estimates nor for monitoring population trends. None of the surveys employed a systematic field survey of all potential habitat in the area reported on (i.e., a state or region), and none incorporated a statistical design which would allow for confidence limits to be placed on the population estimates; consequently, the accuracy and precision of the estimates are unknown.

In 1979, Region 4 of the U. S. Fish and Wildlife Service, in cooperation with the USDA Forest Service, initiated a rangewide census of red-cockaded woodpecker colonies on Federal lands. The census encompassed most national forests, national wildlife refuges, and military bases known or suspected to support red-cockaded populations. The census was restricted to Federal lands because of funding, logistics, and the priority responsibility of Federal land managers to manage red-cockaded habitat. A sampling scheme was employed which permitted calculation of confidence limits around the population estimates and allowed for the survey to be repeated in future years to establish population trends. The results of the census indicated there are 2,677 (±456) active red-cockaded woodpecker colonies on the Federal lands censused (Table 1).

A few Federal properties known to have moderate to high numbers of colonies were not included in the survey. For example, in North Carolina the Croatan National Forest is reported to have 43 active colonies and Camp LeJeune 26 colonies (Carter et al. 1983), in South Carolina the Sandhills State Forest contiguous with the Sandhills National Wildlife Refuge supports an estimated 80 colonies (R. Beach per. comm.), Fort Stewart in Georgia has an estimated 209 colonies (L. Swindell per. comm.), and in Florida Eglin Air Force Base has an estimated 243 colonies and 4 other Federal holdings there have a combined total of 59 (Wood & Wenner 1983). The total number of active colonies on all Federal lands therefore probably exceeds 3,000.

Among the three ownerships censused, the largest number of active colonies (2,121) was found on national forests. This is consistent with

Table 1. An estimate of the number of active red-cockaded woodpecker colonies on selected Federal forests in the South.[1]

Forest property	State	Survey estimate	Adjusted estimate
National Forests			
Angelina	TX	6 ± 13	6 ± 12
Apalachicola	FL	560 ± 122	510 ± 128
Bankhead	AL	8 ± 20	8 ± 19
Bienville	MS	93 ± 82	85 ± 76
Conecuh	AL	17 ± 26	15 ± 24
Davy Crockett	TX	53 ± 26	48 ± 24
DeSoto	MS	163 ± 108	148 ± 100
Francis Marion	SC	406 ± 168	370 ± 161
Homochitto	MS	29 ± 26	26 ± 24
Kisatchie	LA	471 ± 177	430 ± 171
Ocala	FL	41 ± 76	38 ± 70
Osceola	FL	48 ± 25	44 ± 23
Sabine	TX	36 ± 60	32 ± 55
Sam Houston	TX	189 ± 131	172 ± 122
Savannah River	SC	18 ± 48	17 ± 44
Sumter	SC	0 ± 0	0 ± 0
Talladega	AL	189 ± 71	172 ± 69
Total		2327 ± 339	2121 ± 405
Military Bases			
Ft. Benning	GA	70 ± 28	64 ± 27
Ft. Bragg[2]	NC	219 ± 38	200 ± 43
Ft. Gordon	GA	0 ± 0	0 ± 0
Ft. Jackson	SC	19 ± 17	18 ± 16
Ft. McClellan	AL	0 ± 0	0 ± 0
Ft. Polk	LA	38 ± 27	34 ± 25
Avon Park AFB	FL	28 ± 28	25 ± 25
Barksdale AFB	LA	0 ± 0	0 ± 0
Tyndall AFB	FL	0 ± 0	0 ± 0
Total		373 ± 59	340 ± 69
National Wildlife Refuges			
Carolina Sandhills	SC	139 ± 0	127 ± 0
D'Arbonne	LA	5 ± 0	5 ± 0
Felsenthal	AR	20 ± 0	18 ± 0
Mattamuskeet	NC	0 ± 0	0 ± 0
Noxubee[2]	MS	12 ± 0	11 ± 0

Table 1. An estimate of the number of active red-cockaded woodpecker colonies on selected Federal forests in the South. (continued)

Forest property	State	Survey estimate	Adjusted estimate
National Wildlife Refuges (Continued)			
Okefenokee[2]	FL-GA	28 ± 0	26 ± 0
Pee Dee	NC	3 ± 0	3 ± 0
Piedmont	GA	23 ± 0	21 ± 0
Santee	SC	4 ± 0	4 ± 0
St. Marks	FL	3 ± 0	3 ± 0
Swan Quarter	NC	0 ± 0	0 ± 0
Total		237 ± 0	216 ± 0
Total - all Federal properties		2937 ± 344	2677 ± 456

[1]Lennartz et al. 1983b.
[2]Survey is incomplete and thus an underestimate.

land ownership patterns. The Forest Service administers approximately 74% of the Federal forest properties in the South (USDA 1978), and these lands support approximately 79% (2,121/2,677) of the red-cockaded colonies found on the Federal forests censused. Largest concentrations of active colonies were found in the Sandhills of the two Carolinas (Fort Bragg and Carolina Sandhills National Wildlife Refuge), the Atlantic Coastal Plain (Francis Marion National Forest), the North Florida Coastal Plain (Apalachicola National Forest), and the Gulf Coastal Plain (Talladega, Kisatchie, and Sam Houston National Forests). The majority of these centers of abundance seem to closely coincide with the distribution of the longleaf pine type (cf. USDA 1965 and 1969).

The census estimate developed for Federal lands cannot be expanded to forest properties that were not surveyed to derive a total rangewide population estimate. However, if one examines the amount and distribution of potential habitat on lands not censused, inference can be made of the probable occurrence of red-cockadeds on these lands. Throughout the South, the majority of forest land (91%) is in private ownership, and these private forests contain approximately 75% of the existing old-growth pine habitat (Lennartz et al. 1983a). With three times as much potential habitat as public lands, private lands may harbor substantial numbers of red-cockaded woodpeckers. It is unlikely, however, that private lands support red-cockaded populations in proportion to their acreage. Private forest land is distributed among smaller and less consolidated parcels than Federal forests, and there is little uniformity in habitat conditions and forest management programs on private lands. Consequently, probably few individual private forest

properties are capable of supporting very large red-cockaded populations.

The current trend in red-cockaded populations is uncertain. Jackson (1978b) has noted that some population estimates have been unintentionally inflated by observers failing to distinguish between active and inactive colonies. By the same token, some reports of population declines were unintentionally biased by observers resurveying only active colonies and detecting losses without surveying previously unoccupied habitats to detect shifts in colony locations or new colonies. Consequently, the loss of 13.1 percent of 312 active colonies reported by Thompson (1976) and the 34% loss of 141 active colonies reported by Baker (1982) may or may not represent net population reductions. The reports by Thompson (1976) and Baker (1982), however, clearly indicate that active colonies are far from stable and many are being lost. And there is unequivocal evidence that some local populations have declined or been extirpated (e.g., Tall Timbers Research Station, Baker 1983; Oconee National Forest, Ben Sanders per. comm.; Savannah River Plant, Jerome Jackson per. comm.).

Whether or not new colonies are being established to offset colony loss is unknown. None have been reported, but no forest property has been thoroughly and systematically surveyed over time. Until the rangewide census on Federal lands is repeated, and individual forests institute statistically valid population monitoring programs, it is likely that impressions and opinions about trends in red-cockaded populations will remain speculative and controversial.

Red-cockaded woodpecker nesting habitat

The most often cited threat to red-cockaded woodpecker populations is the loss of old-growth southern pines required by the woodpecker for nesting habitat. The trend in old-growth pine acreage across the South has been estimated by Lennartz et al. (1983a) using data from the periodic forest surveys conducted by the USDA Forest Service. From the data on habitat trends, one can infer the probable trends in red-cockaded populations.

Throughout the South, stands of old-growth pine required by red-cockadeds for nesting habitat are a scarce and declining resource. Only about 2.5% of the commercial pine acreage in the South, or 1.6 million acres, is acceptable red-cockaded nesting habitat (Tables 2 and 3). The majority of available nesting habitat is found on private land, but public lands support approximately two-and-one-half times more nesting habitat than would be expected based on the proportion of forest land in public ownership. Over the past 30 years, the total acreage of old-growth pine has declined by 13% (Table 4). Among the major southern pine types, the largest proportional decrease has been in the longleaf-slash pine type. This is of particular concern because longleaf-slash is the more restricted of the two major southern pine types, and it is also the type thought to be preferred by red-cockadeds for nesting habitat (cf. Lowery 1960, Baker 1982, Lennartz et al. 1983a).

Lennartz et al. (1983a) found a significant, positive correlation between the number of active red-cockaded colonies and the acreage of old-growth longleaf-slash pine on Federal lands. Considering this relationship, it is logical to assume red-cockaded woodpecker populations have been reduced as nesting habitat has declined.

Table 2. Rangewide estimates of the amount and distribution of potential red-cockaded woodpecker nesting habitat on commercial forest land (all acceptable pine types, 60 years and older).[1]

Region/ state	All ownerships	National forest	Other federal	Other public	Private
	1,000 acres				
Southeast					
Virginia	15.7	0	0	4.0	11.7
North Carolina	206.3	4.1	14.5	40.9	146.8
South Carolina	115.9	13.7	10.1	15.5	76.6
Georgia	207.4	0	17.6	0	189.8
Florida	154.4	60.3	13.1	6.6	74.4
Subtotal	699.7	78.1	55.3	67.0	499.3
Midsouth					
Alabama	180.1	11.0	2.1	6.1	160.9
Mississippi	95.5	28.1	0	4.3	63.1
Louisiana	94.7	6.3	0	1.2	87.2
Texas	240.0	53.8	9.0	4.8	181.4
Oklahoma	33.3	11.0	0	0	22.3
Arkansas	239.1	67.0	5.4	6.6	160.1
Tennessee	50.1	8.2	0	0	41.9
Subtotal	932.8	185.4	7.5	23.0	716.9
TOTAL	1,632.5	263.5	62.8	90.0	1,216.2

[1]Lennartz et al. 1983a.

Table 3. Availability of red-cockaded woodpecker nesting habitat relative to forested land area in the South (1,000 acres).[1]

	Southeast	Midsouth	Total south
	----------1,000 acres----------		
Total land area	147,818.2	362,959.0	510,777.2
Commercial forest land	87,819.4	100,226.4	188,045.8
Acreage in major southern pine forest types	34,598.4	28,732.3	63,330.7
Acreage of red-cockaded woodpecker nesting habitat	699.7	932.8	1,632.5

[1]Lennartz et al. 1983a.

Table 4. Trends in acreage of commercial forest land in the South supporting pine sawtimber stands by broad forest types and ownership class, 1953-1977[1].

Forest type	Year	All ownership classes	Ownership class			
			National forest	Other public	Forest industry	Other private
		----------Thousand acres----------				
Longleaf/ slash pine	1953	6,910	574	484	1,962	3,890
	1963	6,647	538	465	1,888	3,756
	1970	6,087	520	453	1,764	3,350
	1977	5,196	539	468	1,343	2,846
	1953-1977	-25%	-6%	-3%	-32%	-27%
Loblolly/ shortleaf pine	1953	20,624	1,727	552	5,560	12,785
	1963	19,902	1,897	563	5,531	11,911
	1970	20,090	1,971	601	5,939	11,579
	1977	18,863	1,987	702	4,689	11,485
	1953-1977	-9%	+15%	+27%	-16%	-10%
All pine types	1953	27,534	2,301	1,036	7,522	16,675
	1963	26,549	2,435	1,028	7,419	15,667
	1970	26,177	2,491	1,054	7,703	14,929
	1977	24,059	2,526	1,170	6,032	14,331
	1953-1977	-13%	+10%	+13%	-20%	-14%

[1]Lennartz et al. 1983a.

II. RECOVERY

A. Biological Perspective

Compared with many other endangered species, the red-cockaded woodpecker is relatively abundant and widespread. The species is known to occur in 12 states throughout the South, and the total population on Federal lands alone numbers at least 2,700 clans or breeding units. Considering the availability of potential habitat, numbers of red-cockadeds probably still exist on unsurveyed private lands and other public lands such as State forests and parks. Certainly, a number of active colonies have been documented on State and private forests (Baker 1982, Carter et al. 1983, and Grimes 1977). Some local populations number several hundred clans, so it would not appear that the species is threatened with imminent extinction.

At this time, however, the species' prospects for long-term survival are uncertain. Historically, a major proportion of southern pine habitats disappeared when forest land was cleared and converted to other uses. Certainly, red-cockaded woodpeckers disappeared with their habitat, and it can be assumed that the total woodpecker population is lower now than in the historic past. In contemporary times, the decline and extirpation of local woodpecker populations has been documented, and the acreage of old-growth pine nesting habitat is declining throughout the species' range. Forest land continues to be converted to other uses, and pine timberlands are being managed on shortened rotations. There can be little doubt that the total red-cockaded population is declining as potential nesting habitat is diminished.

With the continuing loss of nesting habitat, we can anticipate both a decline in total red-cockaded numbers, and an increasing jeopardy to remaining populations. The Endangered Species Act mandates the management and perpetuation of nesting habitat on Federal lands, but the majority of pine forest land in the South (90%) is in private ownership. Loss of old-growth pine habitats has proceeded most rapidly on private lands, and there are no indications this trend will be halted or reversed. There are no legal requirements or incentive programs to encourage private landowners to perpetuate old-growth pine forests, and economic considerations promote harvesting and regeneration on relatively short rotations. Consequently, whatever red-cockaded populations exist on private lands must be considered in peril. The prospective future is extirpation of the species on most private properties unless efforts are implemented to reverse current habitat trends. With loss of habitats and populations on private lands, public forests become fragmented habitat reserves with their associated woodpecker populations isolated one from another. Population isolation can be expected to restrict gene flow and, among smaller populations, reduce genetic diversity and decrease the populations' adaptability to biotic and abiotic environmental pressures. Small populations isolated from potential immigrants are also more susceptible to total decimation from catastrophic events.

At present the red-cockaded woodpecker's status is in the balance. Populations are large enough, and there is adequate habitat or potential habitat, that populations could be managed for long-term viability. At the same time, populations are threatened with declining availability of

nesting habitat, habitat fragmentation, and population isolation. The species' prospects for survival depend solely on whether and when forest land managers implement programs to provide for the red-cockaded's habitat requirements.

B. Recovery Objectives

The stated purpose of the Endangered Species Act is the conservation of endangered and threatened species and the ecosystems upon which they depend. The ultimate goal of a recovery plan is to prescribe the methods and procedures necessary to bring any endangered or threatened species to the point at which the measures stipulated by the Federal Endangered Species Act are no longer necessary. Consequently, to achieve the purpose of the Endangered Species Act and meet the goal of recovery planning, objectives and procedures must be prescribed that insure that a species is not in danger of extinction nor likely to become in danger of extinction in the foreseeable future, throughout a significant portion of its range.

In establishing recovery objectives for the red-cockaded woodpecker, we make a number of presumptions: (1) the species to be conserved is the sum of local populations and their associated geographical, ecological, and genetic diversity; (2) the species' inherent variability can only be maintained by perpetuating populations in the major physiographic provinces and forest types where the species occurs; (3) conservation implies persistence in perpetuity, which is dependent upon populations sufficiently large to maintain genetic variation for evolutionary adaptation over time; (4) habitat trends and landowner objectives indicate that the most realistic opportunity for

managing red-cockadeds will be on Federal and other public forest properties; and (5) since public forest lands are dispersed throughout the species' range in fragmented parcels, recovery must be planned and managed on a population-by-population or property-by-property basis. Defining a population's demographic and geographic limits is extremely difficult and often arbitrary. Because public lands are dispersed and fragmented, individual forest properties should be considered island habitat preserves. Jay Carter and Phil Doerr (per. comm.) have documented individual red-cockadeds dispersing up to 18 miles. Consequently, forest properties or administrative units greater than 18 miles apart should be considered distinct population management units.

The recovery goal for the red-cockaded woodpecker is to perpetuate viable populations in the major physiographic provinces and forest types where the species currently exists. Perpetuation of currently extant populations would maintain the species throughout most of its historic range. Federal forest properties will be emphasized, but this emphasis does not obviate management for red-cockadeds on other public and private lands. Rather, it acknowledges a primary Federal obligation; recognizes that if Federal land managers respond to the authorities and responsibilities of the Endangered Species Act (especially Section 7), the purpose of the Act would be fulfilled; and presumes a low probability of concerted habitat management on private lands. Certainly, management for red-cockadeds on other public and private lands is encouraged, as such activities can only hasten and increase the probability of the species' recovery.

Because recovery programs must be planned and implemented on a population-by-population basis, this is the basis upon which progress towards recovery should be evaluated. With fragmented habitats, isolated populations, and a species that is nonmigratory, the status of a population in one geographic area has little or no relevance to the status of another population in an area far removed. The status of individual populations should be assessed based upon population size, population growth and stability, and the adequacy of local habitat management programs to perpetuate the populations. Considering the range in sizes of current populations, the species' status will probably vary in different portions of its range. Rangewide recovery, the ultimate goal of this plan, can be achieved when a sufficient number of viable populations are established and protected throughout the species' current range.

Population size and population viability

A recovery goal to maintain viable populations of red-cockaded woodpeckers in the major physiographic provinces and forest types where the species occurs immediately poses the question of what is a viable population. By viable population we mean a population which can be expected to persist in perpetuity. Persistence implies reproduction and survival which depend on a population's capacity to continually adapt to environmental change. The capacity for adaptation is maintained by maintaining genetic variability. The desired level of genetic variability for long-term population viability depends, among other factors, on population size (Frankel and Soule 1981). Franklin (1980) has proposed that a minimum effective population size of 500 breeding

adults is required to maintain desired levels of genetic variation for long-term population viability. For red-cockaded woodpeckers this equates to 250 clans, because each clan contains only two breeding adults. In proposing 500 as the minimum effective population size to maintain long-term genetic variation, Franklin (1980) acknowledged his guideline was based on "extremely meager evidence" and emphasized that genetic deterioration would be far less in populations many times larger. Based on theoretical considerations other than those used by Franklin (1980), Frankel and Soule (1981) also suggested an effective population size of 500 as a lower threshold for maintaining genetic variation and population fitness. Lacking additional guidelines, we propose 250 clans as a guideline for the minimum viable population size for red-cockaded woodpeckers. It should be emphasized that 250 clans is a suggested minimum viable population size. Genetic considerations indicate that the probability of maintaining population fitness and viability is higher at higher population levels, and professional ethics would seem to dictate that a species' survival deserves more than a minimum commitment. Also, the Endangered Species Act establishes as a management goal the conservation of the species and the ecosystem it is dependent upon. Population goals which approximate the range of densities representative of the species' natural occurrence are more likely to conserve ecosystem or community attributes than are token minimum viable populations. While we propose 250 clans as a minimum viable population size, we recommend that forest managers with adequate habitat to support more than 250 clans establish population goals based on the potential carrying capacity of their properties.

Potential carrying capacity

The carrying capacity of an environment for any particular species is the population density of the species the environment can support. Carrying capacity is a function of the resource requirements of the species and the resource availability of the environment. From the perspective of the habitat manager, the resource requirements of the red-cockaded woodpecker are pine and pine-hardwood stands for foraging and mature pine trees for cavities for roosting and nesting. Because red-cockadeds have specific requirements for foraging and nesting habitat in terms of stand structure, species composition, and tree age, the carrying capacity of individual forest properties depends upon the species composition, structure, and age of forest habitats available. Different properties will vary in their capability to support red-cockaded populations depending on their history, site capability, and imposed management regime, and the carrying capacity of any given property will vary over time as habitat availability changes as a result of succession, natural disturbance, and management (e.g., fire, harvesting, etc.).

It is a simple matter to list the factors which are likely to influence a forest's carrying capacity for red-cockaded woodpeckers. It is extremely difficult, however, to suggest what population densities might be associated with different levels of habitat availability. Scarcely any information of this sort has appeared in the literature.

One of the largest known populations of red-cockaded woodpeckers occurs on the Francis Marion National Forest in coastal South Carolina (Lennartz et al. 1983b). The Francis Marion encompasses approximately

165,000 acres of pine and pine-hardwood habitats (U.S. Forest Service 1977) and supports an estimated 406 red-cockaded woodpecker clans (Table 1, Lennartz et al. 1983b). The population density is approximately one clan per 400 acres of available habitat. The Francis Marion National Forest is managed under a policy of multiple use, including sustained yield timber production, and a system of even-aged management is used in the harvest and regeneration of pine stands. Approximately 27% of the pine acreage is longleaf pine, 68% loblolly pine, and 2.6% mixed loblolly pine-hardwood. A diversity of stand ages is represented among pine habitats, though a preponderance of the pine acreage is in age classes 30-60 years.

On one census plot of approximately 2,500 acres (1,000 ha) on the Francis Marion, Robert Hooper (per. comm.) documented 22 clans of woodpeckers, or a density of one clan per 112 acres. Habitat on the census plot is essentially a uniform expanse of mature (approximately 100 yrs. old), heavily stocked (80-100 ft^2/acre BA) longleaf pine, interspersed with small areas of narrow drains and pond pine pocosins or bays.

The Hobcaw Barony, also in coastal South Carolina, is a smaller forest property administered by Clemson University as an experimental forest. Management of the forest is less intense than on the Francis Marion. Approximately 6,150 acres of the forest is in pine or pine-hardwood habitats, and the forest supports 25-30 clans of red-cockaded woodpeckers (Grimes 1977). The derived red-cockaded population density is one clan per 200-246 acres of available habitat. Since Hobcaw is managed primarily as a research environment, timber harvesting has been

conducted at a low to moderate scale. A variety of stand age classes can be found on the property, but 75% of the pine acreage is in stands 60 years old and older, and 43 percent is in stands 100 years old and older.

Although based on a limited data base, this range in recorded red-cockaded woodpecker densities provides an approximation of the potential carrying capacity of forests under varying intensities of management. The maximum observed population density of one clan per 112 acres could probably only be achieved in areas where management for the woodpecker is maximized by maintaining essentially the entire forest in well-stocked stands of mature longleaf pine and controlled burning at frequent intervals. A range of one clan per 400 acres of habitat (Francis Marion) to one clan per 200-250 acres of habitat (Hobcaw) is a more realistic objective for most managed forests where timber management is an important landuse objective, and the forest environment will consist of a mosaic of stand age and condition classes.

Summary of recovery objectives

1. The recovery goal for the red-cockaded woodpecker is to perpetuate viable populations in the major physiographic provinces and forest types where the species currently exists.

2. All forest properties with adequate acreage of pine habitat should establish a minimum population goal of 250 woodpecker clans. For administrative units with fragmented and widely disjunct (> 18 miles apart) parcels of land, the minimum population goal should be established for each unit of land.

3. Properties with habitat, or potential habitat, to support more than 250 woodpecker clans should establish population density goals of between one clan per 200-400 acres of pine and pine-hardwood forest types.

4. Populations on properties with limited acreage of habitat are in the greatest jeopardy. Managers of relatively small properties and populations should strive for the highest densities and absolute population levels sustainable in local habitat types. Managers of properties with limited acreage of habitat should also explore opportunities for developing cooperative arrangements with managers of adjacent properties to increase the effective acreage of habitat and the effective population size.

5. Managers of properties with small populations and limited acreage of habitat should also explore opportunities for introducing birds from larger populations to effect gene flow and increase genetic variation.

6. The species' status should be reviewed on a population-by-population basis. In reviewing the status of a population, consideration should be given to population size, the population's trend, and the adequacy of habitat management programs supporting the population. The following criteria will be used to categorize the status of individual populations:

- Endangered.
  - -- Populations smaller than 125 clans.
  - -- Populations between 125 and 250 clans subject to diminishing habitat.
- Threatened.

-- Populations between 125 and 250 clans supported by habitat management programs judged adequate by the U. S. Fish and Wildlife Service to sustain the populations.

-- Populations larger than 250 clans on properties lacking adequate habitat management programs to sustain these populations.

- Recovered.

-- Populations larger than 250 clans supported by habitat management programs judged adequate by the U. S. Fish and Wildlife Service to sustain the populations.

Achievement of the criteria listed above under "Threatened" or "Recovered" for an individual population will signify significant progress towards achieving the rangewide recovery objective. The Fish and Wildlife Service will publicly recognize the responsible management agency for such achievement. However, formal regulatory changes to either delist or down-list to threatened status will be proposed for the species only on a rangewide basis.

7. Rangewide recovery will be achieved when a sufficient number of viable populations are established and protected by adequate habitat management programs throughout the major physiographic provinces and within the major forest cover types which can be managed to sustain viable populations. Physiographic provinces and forest cover type classifications follow Braun (1950) and Eyre (1980). The distribution and abundance of the species coincides primarily with the Coastal Plain (Atlantic, Gulf, and Sandhills), and Piedmont physiographic provinces. Forest types supporting significant numbers of active red-cockaded

colonies include longleaf, longleaf-slash, longleaf-scrub oak, loblolly, and loblolly-shortleaf.

The following criteria will be used to determine rangewide status:

- Endangered
  - -- No viable populations in one or more of the areas defined in the distribution necessary for threatened status.
- Threatened: at least six viable populations established with the following distribution;
  - -- One population in the Coastal Plain of North Carolina or South Carolina;
  - -- One population in the Sandhills of North Carolina or South Carolina;
  - -- One population in the Coastal Plain of Georgia or peninsular Florida;
  - -- One population in the Coastal Plain of Alabama or the Florida panhandle;
  - -- One population in the Coastal Plain of Mississippi; and
  - -- One population in the Coastal Plain of Louisiana or Texas.
- Recovered: at least 15 viable populations established with the following distribution:
  - -- One population in the Coastal Plain of North Carolina; Croatan
  - -- One population in the Coastal Plain of South Carolina; Francis Marion
  - -- One population in the Sandhills of North Carolina;
  - -- One population in the Sandhills of South Carolina;
  - -- One population in the Coastal Plain of Georgia;
  - -- One population in the Coastal Plain of peninsular Florida; Osceola

-- Two populations in the Coastal Plain of southern Alabama or Conecuh the Florida panhandle; Apalachicola

-- One population in the Coastal Plain in central Alabama; Oakmulgee

-- One population in the Piedmont of North Carolina, South Carolina, or Georgia; Oconee

-- One population in the Piedmont of Alabama; Talladega

-- One population in the upper Coastal Plain of Mississippi; Bienville

-- One population in the lower Coastal Plain of Mississippi; Desoto

-- One population in the Coastal Plain of Louisiana; and Kisatchie, Vernon, Evangeline

-- One population in the Coastal Plain of east Texas. Sam Houston

The Fish and Wildlife Service will consider formal regulatory action to change the status of the species when the responsible management agencies provide for each population: (1) an accurate population estimate showing an upward or stable trend, (2) an adequate habitat management program to sustain the population, and (3) a plan for continued monitoring of the populations. Should the monitoring detect declining population trends, the Fish and Wildlife Service must be consulted.

If the species is down-listed from endangered to threatened, the provisions of the Endangered Species Act are still applicable to the protection and management of all populations. Any actions, including habitat management, that may affect the species must be consulted on with the Fish and Wildlife Service. If the species is considered recovered and proposed for delisting, all populations will continue to receive protection under the Migratory Bird Treaty Act, the National Forest Management Act and appropriate State statutes covering endangered, threatened, or sensitive species.

C. Step-down Outline of Recovery Activities

1. Survey, monitor, and assess the status of individual populations and the species.
   - 1.1. Survey red-cockaded woodpecker populations on Federal and other public lands not previously surveyed.
   - 1.2. Conduct rangewide survey at 5-10 yr. intervals.
     - 1.2.1. Utilize statistically valid techniques to conduct intensified surveys of individual populations.
     - 1.2.2. Based upon recovery objective criteria, assess the status of individual populations and the species rangewide.
2. Implement protection and management of nesting and foraging habitat on Federal lands.
   - 2.1. Protect and manage all currently active red-cockaded colonies.
   - 2.2. Manage habitat for present and future nesting and foraging needs.
     - 2.2.1. Provide adequate nesting habitat, in addition to currently active colony sites, to replace colony sites abandoned or lost through mortality, and to provide for population expansion.
     - 2.2.2. Provide adequate foraging habitat to support existing colonies and clans and to facilitate establishment of new territories.
   - 2.3. Assess the adequacy of established and proposed management programs.
3. Encourage protection and management on private lands.

3.1. Provide information on management and legal requirements to private landowners and managers.

3.1.1. Develop information articles and management guidelines oriented to private lands.

3.1.2. Distribute information to private landowners and managers through professional and industrial associations.

3.2. Develop model cooperative agreement between Federal agencies and private landowners and implement where feasible.

3.3. Protect red-cockaded woodpecker habitat on private lands through easements, acquisitions and donations.

3.4. Recognize or reward protection and management efforts.

3.4.1. Provide favorable publicity through news media.

3.4.2. Provide certificates of recognition.

3.4.3. Explore, and implement, if feasible, tax incentive programs.

4. Conduct research on habitat needs and management, population dynamics, and genetic variation.

4.1. Extend information on nesting habitat selection and refine guidelines for managing nesting habitat.

4.1.1. Test and compare alternative methods for providing nesting habitat (e.g., lengthened rotations, remnant patches, and remnant trees).

4.1.2. Determine at what hardwood stocking levels pine stands become unacceptable as red-cockaded nesting habitat.

4.1.3. Determine the biological processes associated with colony abandonment (e.g., interspecific competition, predation, etc.).

4.1.4. Develop guidelines for treating colony sites to prevent colony abandonment.

4.1.5. Determine if abandoned colonies can be treated to attract clans back to the site.

4.1.6. Develop methods for minimizing the probability of bark beetle infestation and spread in active colonies.

4.1.7. Determine whether retention of snags and dead and abandoned cavity trees within colonies increases or decreases competitive pressure on red-cockadeds.

4.2. Extend information on foraging habitat selection and refine guidelines for managing foraging habitat.

4.2.1. Determine preference for foraging in stands of various ages, stockings, and species composition.

4.2.2. Determine relationships between quantity and quality of foraging habitat and reproduction, survival, and population dynamics.

4.3. Explore the dynamics of red-cockaded woodpecker populations.

4.3.1. Determine the process and rate of new colony formation.

4.3.2. Relate population dynamics to habitat use and availability.

4.3.3. Explore techniques for translocating red-cockadeds to establish new populations, to enhance gene flow, or to salvage colonies threatened with destruction.

4.4. Explore the relationship between population dynamics and genetic structure of red-cockaded populations.

4.4.1. Develop methods for determining genetic variation within populations.

4.4.2. Explore the relationship between genetic variation and population size.

4.4.3. Develop guidelines for maintaining or increasing genetic variation.

5. Inform and involve the public.

5.1. Prepare informative articles for the news media and popular publications.

5.2. Distribute information to the public via mailings to conservation groups and individuals and through public meetings.

D. Narrative Outline of Recovery Activities

1. Survey, monitor, and assess the status of individual populations and the species. The status of the red-cockaded woodpecker will remain uncertain and controversial until reliable census data is acquired both for individual populations and for the rangewide population. A rangewide survey was completed for most Federal lands in 1982. The sampling intensity employed in the original survey is adequate for establishing a reliable rangewide population estimate. The census technique developed by Harlow et al. (1983) has proven highly accurate and cost effective in both Coastal Plain and Piedmont forests.

1.1. Survey red-cockaded woodpecker populations on Federal and other public lands not previously surveyed. The rangewide survey should be expanded to include Federal properties not included in the original survey as well as other public forest properties such as state forests, parks, and game lands.

1.2. Conduct rangewide survey at 5-10 yr. intervals. The rangewide survey should be repeated at five- to ten-year intervals to determine rangewide trends.

1.2.1. Utilize statistically valid techniques to conduct intensified surveys of individual populations. Precise estimates and the analysis of trends for individual properties will require a higher sampling intensity than that utilized in the rangewide survey. On properties with small (≤ 50 clans) sparse populations, 100% surveys will provide better accuracy and precision than sample surveys. Use of standardized procedures in censusing local populations will facilitate communication among investigators, managers, and policy makers, and permit the summation of local estimates into regional and rangewide estimates.

1.2.2. Based upon recovery objective criteria, assess the status of individual populations and the species rangewide. The ultimate goals of this plan are to eliminate the factors currently threatening red-cockaded woodpecker populations, perpetuate viable

populations throughout the range now occupied by the species, and remove the species from the Federal list of endangered species. As population data is acquired, and population trends established or estimated, the status of individual and rangewide populations should be reviewed as appropriate.

2. Implement protection and management of nesting and foraging habitat on Federal lands.

2.1. Protect and manage all currently active red-cockaded colonies. The major threats to currently active colonies are the loss of cavity trees due to harvesting, lightning, wind-throw or breakage, and beetle infestations and the abandonment of cavity trees due to hardwood encroachment and/or interspecific competition. These threats can be minimized by:

- Managing colony sites as stands rather than as individual trees and not isolating colony sites from adjacent forest cover and foraging habitat.
- Burning or otherwise treating colony areas to control hardwood stocking. Hardwood stocking in colony sites should be kept below 20 ft^2/acre BA, and all hardwood stems one inch and larger within 50 feet of cavity trees should be removed.
- Maintaining a spacing of 20-25 ft. between trees within colony stands to minimize the probability of bark beetle infestation and spread.

While cultural treatments (e.g., burning and thinning) are recommended to maintain proper spacing and species composition in colony sites, such treatments should be scheduled outside the nesting season (April through June) to avoid possible disruption of reproductive activities. Considerable caution and skill is required when using fire to control hardwoods in colony sites. Beckett (1971) noted that when the resin or pitch flow on cavity trees ignites, cavity trees can be damaged and cavities burnt out and enlarged. Hopkins and Lynn (1971) suggested that combustible materials be raked away from the base of cavity trees to reduce the probability of damage. Connor and Locke (1979) and Stamps et al. (1983) have documented, however, that even raking around cavity trees will not protect against fire damage where the fuel load around trees is heavy or when fires become too hot due to wind and other weather conditions. The best solution for preventing fire damage to cavity trees is to burn frequently enough that fuel loads do not become excessive. Where hardwoods have become well developed in a stand, and a hotter than normal burn is required to control them (i.e., a spring or summer fire), or where understory fuel loads are especially heavy (e.g., dense palmetto), the protective measures suggested by Connor and Locke (1979) and Stamps et al. (1983) are recommended. These intensive protective measures are probably also warranted on areas supporting just a few active colonies where loss of just a few trees could have a significant impact on the local population.

Thinning of colony sites will minimize the probability of losing cavity trees to bark beetles. Southern pine beetle infestations are composed of two distinct events, initial infestation and spot spread. The insects first attack stressed trees or trees of low vigor (Hicks 1980). The age and slow growth rates of red-cockaded cavity trees make them susceptible to beetle attack. After initial attack, however, spot spread is related to density of pines in the stand (Hedden and Billings 1979). The probability of beetle attacks switching from an infested tree to an uninfested tree is inversely related to the distance between the trees (Johnson and Coster 1978). It has been shown experimentally in small infestations that the distance that attacks will not switch from an infested tree to an adjacent tree is in the range of 20-25 feet (Gara and Coster 1968). Maintaining a spacing of 20-25 feet among trees within colony areas and in stands adjacent to colony areas will minimize the probability of losing an entire colony to bark beetles.

2.2. Manage habitat for present and future nesting and foraging needs.

2.2.1. Provide adequate nesting habitat in addition to currently active colony sites, to replace colony sites abandoned or lost through mortality, and to provide for population expansion. The survival of the red-cockaded woodpecker ultimately depends on halting the loss of nesting habitat and providing adequate acreage

in old-growth pines in perpetuity. Merely protecting existing colonies will delay extinction but not prevent it. A continuing supply of old-growth habitats is required to replace colonies lost or abandoned and to provide for population expansion. Potential cavity trees can be provided by lengthened rotations, by leaving old-growth remnant trees well distributed throughout younger stands, by perpetuating small remnant stands or patches of old-growth throughout the forest area, or by a combination of these methods. Potential cavity trees are longleaf pines 95 years old and older and other pines 75 years old and older on the average. Longleaf pine is an apparently preferred habitat, and longleaf regeneration should be encouraged on all sites the species is adapted to. Longleaf stands should definitely not be regenerated to other pine species. Potential nesting habitat should be burned and thinned similar to colony stands.

2.2.2. Provide adequate foraging habitat to support existing colonies and to facilitate establishment of new territories. Although the loss of nesting habitat is the most serious threat to red-cockaded populations, woodpecker clans cannot survive without adequate acreage of foraging habitat as well. Fortunately, the species is less specialized in its selection of

foraging habitat. Well-stocked (≥ 60 ft^2/acre BA) pine and pine-hardwood stands (≥ 50% BA in pine), 30 years old and older, with more than 24 pines per acre ≥ 10 in. dbh, constitute preferred foraging habitat. Red-cockaded clans require extensive areas for foraging, and 125 acres of acceptable foraging habitat should be provided contiguous with, and within 0.5 mi. of, all active colonies and sites where nesting habitat is being provided to facilitate population expansion. Forty percent of the 125 acres should be in stands 60 years old and older. On forests with young, small diameter, or sparsely stocked pine habitats, larger acreages of foraging habitat should be provided to supply equivalent amounts of foraging substrate. Equivalent foraging substrate should contain 21,250 pine stems with a total BA of 8,490 ft^2 and 6,350 pine stems ≥ 10 in. dbh. The acreage required to provide equivalent amounts of foraging substrate should be developed with knowledge of local stand conditions and reference to local or regional stand tables and should be based on the foraging habitat requirement most lacking in the local area.

2.3. Assess the adequacy of established and proposed management programs. This is a continuous task that is accomplished largely through Section 7 of the Endangered Species Act. All Federal agencies must review their established and proposed

programs and for those that "may affect" the species, initiate consultation with the Fish and Wildlife Service. The Service will then review the action and prepare a biological opinion which addresses the liklihood of jeopardy to the continued existence of the species if the action is carried out. If jeopardy is likely, alternatives to remove jeopardy are presented in the opinion. It is obvious that all management programs for the species represent a "may affect" situation requiring consultation.

3. Encourage protection and management on private lands. Private lands contain the majority of forest land (91%) and 75% of the existing old-growth pine habitat in the South (Lennartz et al. 1983a). Therein lies significant potential for benefit to the species through proper management. These private lands are especially important when adjacent to Federal lands, where they may link populations on the Federal tracts and add to the overall habitat base for the species. In some cases, Federal and private lands combined may be necessary to provide sufficient habitat to support viable populations. However, promotion of protection and management on private lands is difficult because of fewer legal responsibilities and greater economic interests of private landowners. Therefore, special efforts are needed on private lands.

3.1. Provide information on management and legal requirements to private landowners and managers.

3.1.1. Develop information articles and management guidelines oriented to private lands. Information articles and

management guidelines oriented to private lands should be developed. These articles and guidelines should include information and visual aids to identifying habitat of the species, detailed information for managing the species by an array of options depending on the total land management objectives of the owner or manager, and specific information on the legal responsibilities of private landowners through Section 9 of the Endangered Species Act. Legal responsibilities under Section 7 of the Endangered Species Act should also be detailed to explain the different obligations when there is Federal involvement of any kind.

3.1.2. Distribute information to private landowners and managers through professional and industrial associations. The information developed in 3.1.1. should be distributed through a variety of professional and industrial associations and agencies, such as the State and Private Forestry branch of the USDA Forest Service, county agricultural extension agents, and state forestry associations.

3.2. Develop model cooperative agreement between Federal agencies and private landowners and implement, where feasible. This agreement should specify management actions needed to protect the species and identify the party responsible (landowner or Federal agency) for implementing the various actions. The

agreement should set forth the total commitments of the two parties including land base, funds, equipment, manpower, and time period, and provide a means and time frame for terminating the agreement.

3.3. Protect red-cockaded woodpecker habitat on private lands through easements, acquisitions and donations. Opportunities in this regard may be limited because the wide distribution of the species and the large land base needed to support significant populations would likely reduce priorities for this species in comparison to other endangered or threatened species. However, lands containing red-cockaded woodpeckers should receive special consideration where these lands would consolidate Federal ownership or control and contribute to overall resource management objectives of the agencies. Private landowners should be encouraged to avail themselves of these options.

3.4. Recognize or reward protection and management efforts. Management efforts on private lands should be recognized and rewarded in any way possible in light of the limited legal responsibilities involved.

3.4.1. Provide favorable publicity through news media. News media should be contacted and encouraged to provide favorable publicity to deserving landowners. News articles should be prepared for the news media where desirable or requested.

3.4.2. Provide certificates of recognition. Certificates of recognition signed by public officials should be provided worthy landowners, and the receipt of these certificates will also be publicized.

3.4.3. Explore, and implement, if feasible, tax incentive programs. The opportunities for a model tax incentive program at State and Federal levels should be explored and implemented if feasible.

4. Conduct research on habitat needs and management, population dynamics, and genetic variation. Priority research needs are listed in the step-down outline and below, and the objectives are self explanatory. Certain issues, however, have arisen more frequently than others during the Biological Consultation process, and new information to resolve those issues would greatly facilitate management planning and interagency cooperation to recover the species. Of particular concern or interest are:

- The best method(s) to provide nesting habitat (2.2.1. and 4.1.1.),
- The relationship between quantity and quality of foraging habitat (2.2.2., 4.2.1., and 4.2.2.),
- The amount of foraging habitat required to sustain a clan of woodpeckers (2.2.2. and 4.2.2.), and
- The process and rate of new colony formation (4.3.1.).

4.1. Extend information on nesting habitat selection and refine guidelines for managing nesting habitat.

4.1.1. Test and compare alternative methods for providing nesting habitat (e.g., lengthened rotations, remnant patches, and remnant trees).

4.1.2. Determine at what hardwood stocking levels pine stands become unacceptable as red-cockaded nesting habitat.

4.1.3. Determine the biological processes associated with colony abandonment (e.g., interspecific competition, predation, etc.).

4.1.4. Develop guidelines for treating colony sites to prevent colony abandonment.

4.1.5. Determine if abandoned colonies can be treated to attract clans back to the site.

4.1.6. Develop methods for minimizing the probability of bark beetle infestation and spread in active colonies.

4.1.7. Determine whether retention of snags and dead and abandoned cavity trees within colonies increases or decreases competitive pressure on red-cockadeds.

4.2. Extend information on foraging habitat selection and refine guidelines for managing foraging habitat.

4.2.1. Determine preference for foraging in stands of various ages, stockings, and species composition.

4.2.2. Determine relationships between quantity and quality of foraging habitat and reproduction, survival, and population dynamics.

4.3. Explore the dynamics of red-cockaded woodpecker populations.

4.3.1. Determine the process and rate of new colony formation.

4.3.2. Relate population dynamics to habitat use and availability.

4.3.3. Explore techniques for translocating red-cockadeds to establish new populations, to enhance gene flow, or to salvage colonies threatened with destruction.

4.4. Explore the relationship between population dynamics and genetic structure of red-cockaded populations.

4.4.1. Develop methods for determining genetic variation within populations.

4.4.2. Explore the relationship between genetic variation and population size.

4.4.3. Develop guidelines for maintaining or increasing genetic variation.

5. Inform and involve the public. This is an ongoing task. Particular emphasis should be placed on explaining the status, importance and biological needs of the species and the legal responsibilities for the species' protection.

5.1. Prepare informative articles for the news media and popular publications. Information articles for the news media and popular publications should be prepared. The news media should be contacted and encouraged to utilize the information articles as prepared or incorporate all or part of the information in articles prepared by news media staff.

5.2. Distribute information to the public via mailings to conservation groups and individuals and through public meetings. The popular publications should be distributed to the public via mailings to conservation groups and individuals, and through public meetings. Availability of the publications should be publicized and the public encouraged to request copies.

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Part III Implementation Schedule

General Category	Plan Task	Task Number	Priority	Task Duration	Responsible Agency			Estimated Fiscal Year Costs (Thousands)			Comments/Notes
					FWS Region	FWS Program	Other	FY 1	FY 2	FY 3	
I1	Determine populations on non-surveyed lands.	1.1	3	2 yrs.	2,4,5	SE	FS, DOD, SWA	50	50	---	Abbreviations:
I1	Conduct intensified surveys of individual populations.	1.2.1	2	Continuous	2,4,5	SE	FS, DOD	125	125	125	FS - USDA Forest Service/National Forest Systems
I1	Assess individual and range-wide populations.	1.2.2	3	Continuous	2,4,5	SE	FS	20	20	20	DOD - Department of Defense SWA - State Wildlife Agencies FA - Federal Agencies AI - Academic Institutions
M3	Protect and manage colonies.	2.1	1	Continuous	2,4,5	SE, WR	FA, SWA	500	500	500	SE - Endangered Species WR - Refuges and Wildlife
M3	Provide adequate nesting habitat.	2.2.1	1	Continuous	2,4,5	SE, WR	FA, SWA	500	500	500	FS/SPF - USDA Forest Service/State and Private Forestry
M3	Provide adequate foraging habitat.	2.2.2	1	Continuous	2,4,5	SE, WR	FA, SWA	250	250	250	CO - Conservation Organizations PA - Public Affairs RE - Realty LE - Law Enforcement
M3	Assess adequacy of management.	2.3	1	Continuous	2,4,5	SE	FS, AI, SWA	50	50	50	SFA - State Forestry Associations AEA - County Agricultural Extension Agents
O1	Develop articles and guidelines oriented to private lands.	3.1.1	3	Continuous	2,4,5	SE, PA, LE	FS/SPF, SWA, CO, SFA, AEA	8	8	8	FS/R - USDA Forest Service/Experiment Stations C - Contractors
O1	Distribution of information to private landowners and managers.	3.1.2	3	Continuous	2,4,5	SE, PA, LE	FS/SPF, SWA, CO, SFA, AEA	2	2	2	* - On a case-by-case basis, costs unknown and cannot be projected.
A3	Develop and implement cooperative agreements.	3.2	3	Continuous	2,4,5	SE	FS, SWA	5	5	5	
A2,6,7	Protect habitat through easements, acquisitions, and donations.	3.3	3	Continuous	2,4,5	SE, RE	FS, SWA, CO	*	*	*	
O1	Provide favorable publicity.	3.4.1	3	Continuous	2,4,5	SE, PA	FS, SWA	2	2	2	

Part III Implementation Schedule

General Category	Plan Task	Task Number	Priority	Task Duration	Responsible Agency			Estimated Fiscal Year Costs			Comments/Notes
					FWS						
					Region	Program	Other	FY 1	FY 2	FY 3	
01	Provide certificates of recognition.	3.4.2	3	Continuous	2,4,5	SE, PA	FS, SWA	1	1	1	
01	Explore and implement tax incentive programs.	3.4.3	3	Continuous	2,4,5	SE, PA	FS, SWA	2	2	2	
R4	Test and compare methods for providing nesting habitat.	4.1.1	2	10 yrs.	2,4,5	SE, WR	FS/R, SWA AI, DOD, C	25	25	25	
R3,10	Determine hardwood stocking levels unacceptable as nesting habitat.	4.1.2	2	10 yrs.	2,4,5	SE, WR, LE	FS/R, SWA AI, DOD, C	25	25	25	
R3,10	Determine biological processes associated with colony abandonment.	4.1.3	2	10 yrs.	2,4,5	SE, WR, LE	FS/R, SWA AI, DOD, C	40	40	40	
R14	Develop guidelines for treating colony sites to prevent colony abandonment.	4.1.4	2	10 yrs.	2,4,5	SE, WR	FS/R, SWA AI, DOD, C	20	20	20	
R4	Determine if abandoned colonies can be treated to attract clans back.	4.1.5	2	10 yrs.	2,4,5	SE, WR	FS/R, SWA AI, DOD, C	10	10	10	
R4	Develop methods for minimizing probability of bark beetle infestation and spread in active colonies.	4.1.6	2	10 yrs.	2,4,5	SE, WR	FS/R, SWA AI, DOD, C	10	10	10	
R10	Determine whether retention of snags and abandoned cavity trees increases or decreases competitive pressure.	4.1.7	2	10 yrs.	2,4,5	SE, WR	FS/R, SWA AI, DOD, C	20	20	20	

Part III Implementation Schedule

General Category	Plan Task	Task Number	Priority	Task Duration	Responsible Agency			Estimated Fiscal Year Costs			Comments/Notes
					FWS Region	FWS Program	Other	FY 1	FY 2	FY 3	
R3	Determine preference for foraging in stands of various ages, stockings, and species composition.	4.2.1	2	10 yrs.	2,4,5	SE, WR	FS/R, SWA AI, DOD, C	50	50	50	
R3,4	Determine relationships between quantity and quality of foraging habitat and reproduction, survival, and population dynamics.	4.2.2	2	10 yrs.	2,4,5	SE, WR	FS/R, SWA AI, DOD, C	100	100	100	
R1,6	Determine process and rate of new colony formation.	4.3.1	3	10 yrs.	2,4,5	SE, WR	FS/R, SWA AI, DOD, C	50	50	50	
R1,6	Relate population dynamics to habitat use and availability.	4.3.2	3	10 yrs.	2,4,5	SE, WR	FS/R, SWA AI, DOD, C	50	50	50	
R16,13	Explore techniques for translocating red-cockadeds.	4.3.3	3	10 yrs.	2,4,5	SE, WR	FS/R, SWA AI, DOD, C	50	50	50	
R1,6	Develop methods for determining genetic variation within populations.	4.4.1	3	10 yrs.	2,4,5	SE, WR	FS/R, SWA AI, DOD,C	20	20	20	
R1,6	Explore relationship between genetic variation and population size.	4.4.2	3	10 yrs.	2,4,5	SE, WR	FS/R, SWA AI, DOD, C	20	20	20	
R1,6	Develop guidelines for maintaining or increasing genetic variation.	4.4.3	3	10 yrs.	2,4,5	SE, WR	FS/R, SWA AI, DOD, C	10	10	10	
O1	Prepare informative articles for news media and publications.	5.1	3	Continuous	2,4,5	SE, PA	FS/SPF, SWA, CO	8	8	8	

Part III Implementation Schedule

General Category	Plan Task	Task Number	Priority	Task Duration	Responsible Agency			Estimated Fiscal Year Costs			Comments/Notes
					FWS						
					Region	Program	Other	FY 1	FY 2	FY 3	
01	Distribute information to the public.	5.2	3	Continuous	2,4,5	SE, PA	FS/SPF, SWA, CO	2	2	2	

KEY TO IMPLEMENTATION SCHEDULE COLUMNS 1 AND 4

General Category (Column 1):

Information Gathering - I or R (research)

1. Population status
2. Habitat status
3. Habitat requirements
4. Management techniques
5. Taxonomic studies
6. Demographic studies
7. Propagation
8. Migration
9. Predation
10. Competition
11. Disease
12. Environmental contaminant
13. Reintroduction
14. Other information

Acquisition - A

1. Lease
2. Easement
3. Management agreement
4. Exchange
5. Withdrawal
6. Fee title
7. Other

Other - O

1. Information and education
2. Law enforcement
3. Regulations
4. Administration

Management - M

1. Propagation
2. Reintroduction
3. Habitat maintenance and manipulation
4. Predator and competitor control
5. Depradation control
6. Disease control
7. Other management

Priority (Column 4):

1 - An action that must be taken to prevent extinction or to prevent the species from declining irreversibly in the foreseeable future.

2 - An action that must be taken to prevent a significant decline in species population/habitat quality or some other significant negative impact short of extinction.

3 - All other actions necessary to provide for full recovery of the species.

IV. APPENDIX

LIST OF REVIEWERS FOR THE REVISED RED-COCKADED WOODPECKER RECOVERY PLAN

Ms. Florette Reeder
Florida Power and Light Company
9250 West Flagler
Miami, Florida 33152

Mr. Robert E. Murry, Sr.
Post Office Box 7
Simpson, Louisiana 71474

Mr. Ron Tomas
Attn: DFAE-EECD
Fort Polk, Louisiana 71459

Mr. William Kornman
AFESC/DEVN
Tyndall AFB, Florida 32403

Ms. Phoebe Wray
Center for Endangered Species
175 West Main Street
Ayer, Massachusetts 01432

Dr. James C. Lewis
Georgia Cooperative Wildlife
Research Unit
University of Georgia
Athens, Georgia 30602

Mr. Fred M. Busroe
Department of Biological and
Environmental Science
UPO 1352, Morehead State University
Morehead, Kentucky 40351

Mr. Carl A. Divinyi
Environmental Management Office
U.S. Army Infantry Center
Fort Benning, Georgia 31905

Ms. Trish Patterson
Science Division
U.S. National Park Service
75 Spring Street, S.W.
Atlanta, Georgia 30303

Mr. John M. Bethea, Director
Florida Division of Forestry
Florida Department of Agriculture
and Consumer Services
3125 Conner Boulevard
Tallahassee, Florida 32301

Dr. R. F. Labisky
Florida Cooperative Fish and
Wildlife Research Unit
118 Newins-Ziegler Hall
University of Florida
Gainesville, Florida 32611

Mr. H. H. Shugart
180 North Broadway
El Dorado, Arkansas 71730

Mr. Bill Yambert
Tennessee Wildlife Resources Agency
Route 3, Box 153-A
Talbott, Tennessee 37877

Mr. Gary J. Taylor
Maryland Department of Natural
Resources
P.O. Box 68
Wye Hills, Maryland 21679

Dr. Mitchell Byrd
Biology Department
College of William and Mary
Williamsburg, Virginia 23185

Mr. Fred Burnside
11 Apple Cove
Little Rock, Arkansas 72209

Mr. Larry Landers
Southlands Experimental Forest
Route 3, Box 1788
Bainbridge, Georgia 31717

Mr. Sam VanHook
Avon Park Bombing Range
56 CFS/DEN
Avon Park, Florida 33825

Mr. H. J. Green
North Carolina Department of Natural
Resources and Community Development
P.O. Box 27687
Raleigh, North Carolina 27611

Mr. C. W. Moody, State Forester
Alabama Forestry Commission
513 Madison Avenue
Montgomery, Alabama 36180

Mr. Bruce R. Miles, Director
Texas Forest Service
Texas A&M University
College Station, Texas 77843

Virginia Cooperative Wildlife
Research Unit
100 Cheatham Hall
Virginia Polytechnic Institute
and State University
Blacksburg, Virginia 24061

Wildlife Resources
West Virginia Department of
Natural Resources
1800 Washington Street, East
Charleston, West Virginia 25305

Alabama Cooperative Wildlife
Research Unit
Wildlife Building
Auburn University
Auburn, Alabama 36849

Louisiana Cooperative Wildlife
Research Unit
School of Forestry and Wildlife
Management
Louisiana State University
Baton Rouge, Louisiana 70803

Wildlife Administration
Maryland Department of Natural
Resources
Tawes State Office Building
Annapolis, Maryland 21401

Mississippi Cooperative Fish and
Wildlife Research Unit
Drawer BX
Mississippi State University
Mississippi State, Mississippi 39762

Oklahoma Cooperative Wildlife
Research Unit
404 Life Sciences West
Oklahoma State University
Stillwater, Oklahoma 74074

Mr. Leonard A. Kilian, Jr.
State Forester
Commission of Forestry
P.O. Box 21707
Columbia, South Carolina 29221

Ms. Susan Mashburn
314 N. Gadsden Street
Tallahassee, Florida 32301

Ms. Louise E. Dove
Urban Wildlife Research Center
10921 Trotting Ridge Way
Columbia, Maryland 21044

Mr. Gary A. Breece
Georgia Power Company
791 Dekalb-Industrial Way
Decatur, Georgia 30030

Ms. Ginger A. Murphy
Box 24
Bronston, Kentucky 42518

Mr. Don Harker
Kentucky Nature Preserves Commission
407 Broadway
Frankfort, Kentucky 40601

Mr. John T. Woods
Route 1, Box 207-Z
Midway, Georgia 31320

Ms. Jackie Bellwood
Entomology Department
University of Florida
Gainesville, Florida 32611

Mr. Dennis L. Hart
32 Denton Boulevard, #62
Fort Walton Beach, Florida 32548

Ms. Karilyn Peterson
Breedlove Associates
618 NW. 13th Avenue
Gainesville, Florida 32601

Mr. Steve Dubose
International Paper Company
Georgetown, South Carolina 29440

Mr. Tim Smith
Post Office Box 578
Bristol, Florida 32424

Mr. Michael P. Mety, Assistant Secretary
Office of Forestry
Department of Natural Resources
P.O. Box 1628
Baton Rouge, Louisiana 70821

Dr. Michael H. Smith, Director
Savannah River Ecology Lab
Drawer E
Aiken, South Carolina 36901

Mr. Bill Adams
U.S. Army Corps of Engineers
P.O. Box 1890
Wilmington, North Carolina 28402

Mr. Roy L. Barker
Avon Park Bombing Range
56 CSS/DEN
Avon Park, Florida 33825

Frankie A. Brooks
200 Third Street
Post Office Box 347
Jackson, South Carolina 29831

Mr. John Schill
Alabama Highway Department
11 South Union Street, Room 520
Montgomery, Alabama 36130

Mr. John V. Dennis
Post Office Box 116
Princess Anne, Maryland 21853

Mr. Ted Beckett III
Route 3, Box 331
Johns Island, South Carolina 29455

Dr. James T. Tanner
Department of Zoology
University of Tennessee
Knoxville, Tennessee 37996

Mr. Gilbert T. Crosby
820 Reba Place, Apt. 2-South
Evanston, Illinois 60202

Mr. Scott Shalaway
Department of Zoology
Oklahoma State University
Stillwater, Oklahoma 74078

Mr. Ray Nottingham
Florida Department of Transportation
Post Office Box 1249
Bartow, Florida 33430

Dr. Lawrence Kilham
Department of Microbiology
Dartmouth Medical College
Hanover, New Hampshire 03755

Mr. B. Tanner
Naval Air Station
Pensacola, Florida 32508

Mr. Wayne Howard
Naval Facilities Engineering
Command (Code 243)
2144 Melbourne Street
Post Office Box 10068
Charleston, South Carolina 29411

Mr. B. King
9 Park Road, Newlyn
Penzance, Cornwall
England TR18 5DZ

Mr. Chris Ingram
Gulf South Research Institute
Post Office Box 14787
Baton Rouge, Louisiana 70898

Ms. Elizabeth B. Vanta
834 CSG/DEEV
Hurlburt Field, Florida 32544

Mr. Jon E. Rickert
Avian Publications, Inc.
Post Office Box 310
Elizabethtown, Kentucky 42701

Mr. Sonny Bass
South Florida Research Center
Everglades National Park
Post Office Box 279
Homestead, Florida 33030

Mr. Jerome L. Touval
U.S. Bureau of Land Management
350 South Pickett Street
Alexandria, Virginia 22304

Mr. Wilson Horton
South Carolina Forestry
Commission
Post Office Box 21707
Columbia, South Carolina 29221

Mr. Charles P. Nicholson
Division of Land and Forest Resources
Tennessee Valley Authority
Norris, Tennessee 37828

Mr. Robert E. Beach
Sand Hills State Forest
Post Office Box 128
Patrick, South Carolina 29584

Mr. John Andrews, Forester
Facilities Engineering Division
Office of Assistant Chief of Engineers
Department of the Army
Washington, D.C. 20314

Mr. Craig Watson
6020 Sunbeam Lane, #131
Knoxville, Tennessee 37920

Mr. Jack Mallory
PD-ES
U.S. Army Corpsof Engineers
Box 2288
Mobile, Alabama 36628

Mr. John R. Jansen
Savannah River Operations Office
Department of Energy
Post Office Box A
Aiken, South Carolina 29801

Mr. Ralph W. Dimmick
Department of Forestry, Wildlife and Fisheries
University of Tennessee
Knoxville, Tennessee 37901

Ms. Angi N. Eason
Route 2, Box 425 A-1
Ellabell, Georgia 31308

Mr. John R. Maxwell
1652 Northwest 35th Place
Gainesville, Florida 32605

Mr. Steven H. Everhart
Biology Department
Campbell University
Buies Creek, North Carolina 27506

Mr. John Cely
South Carolina Wildlife Department
Post Office Box 167
Cola, South Carolina 29202

Mr. Lloyd Stith
U.S. Fish and Wildlife Service
1612 June Avenue
Panama City, Florida 32405

Mr. Larry P. Ford
Box 68
Crawfordville, Florida 32327

Mr. Robert V. Riser
131 LeCroy Circle
Brent, Alabama 35034

Mr. Emory J. Moore, Jr.
Post Office Box 65
Glennville, Georgia 30427

Mr. W. V. McConnell
323 Meadowbrook Lane
Tallahassee, Florida 32304

Mr. Carl F. O'Barr
Florida Game and Fresh Water Fish Commission
Post Office Box 401
Port St. Joe, Florida 32456

Mr. Weldon W. Greene
415 Inglewood
Tallahassee, Florida 32301

Ms. Diane Hancock
Post Office Box 571
Forest, Mississippi 39074

Ms. Cynthia Oliver
115 Oakmont Drive
Meflin, Alabama 36264

Mr. Robert Duckworth
1693 Samarin Trail
Tucker, Georgia 30084

Mr. John Mixon, Director
Georgia Forestry Commission
P.O. Box 819
Macon, Georgia 31298

Mr. Danny L. Sewell
Route 12, Box 430
Sanford, North Carolina 27330

Ms. Vickie Sell
Route 1, Box 66A
Haleyville, Alabama 35565

Mr. Michael R. Hurst
C. R. Woodland Cove Estates
Bronston, Kentucky 42518

Mr. Leo F. Labyak
329 Woodside Drive
Hampton, Virginia 23669

Mr. Mark S. Sasser
Florida Game and Fresh Water
Fish Commission
Route 3, Box 179B
Milton, Florida 32570

Mr. Dean M. Simon
N-202 Rogers Road
Athens, Georgia 30609

Ms. Lorna Sicarello
1612 June Avenue
Panama City, Florida 32405

Mr. William Jay Troxel
U.S. Fish and Wildlife Service
1612 June Avenue
Panama City, Florida 32405

Mr. Jack A. Donnelly
Route 3, Box 73
Washington, North Carolina 27889

Mr. Harry W. Allan
Wewa Route, Box 110
Panama City, Florida 32404

Mr. Michael L. Balboni
Post Office Box 615
Crawfordville, Florida 32327

Mr. Stephen R. Adams
Environmental Services and Permitting
2720 N.W. 6th Street, Suite B
Gainesville, Florida 32601

Mr. Preston Toole
Florida Department of Transportation
Post Office Box 607
Chipley, Florida 32428

Mr. Joseph Sheffield
Post Office Box 7
Graceville, Florida 32440

Mr. Billy Hillestead
113 Hoyt Street
Athens, Georgia 30601

Mr. James Garrison
Florida Game and Fresh Water
Fish Commission
Route 1, Box 487
Starke, Florida 32091

Mr. R. Todd Engstrom
Department of Biological Sciences
Florida State University
Tallahassee, Florida 32306

Mr. S. A. Gauthreaux, Jr.
Department of Biological Science
Clemson University
Clemson, South Carolina 29631

Mr. Martin Forsyth
Department of Biology
The Citadel
Charleston, South Carolina 29409

Mr. Keith Bildstein
Department of Biology
Winthrop College
Rock Hill, South Carolina 29733

Mr. George McCoy
Department of Biology
Benedict College
Columbia, South Carolina 29204

Mr. F. Glenn Smith
2230 Devine
Columbia, South Carolina 29205

Mr. Donald A. Hamm, Director
Kentucky Division of Forestry
627 Commanche Trail
Frankfort, Kentucky 40601

Mr. Douglas B. McNair
Department of Biological Science
Clemson University
Clemson, South Carolina 29631

Mr. Rudy Mancke
South Carolina State Museum
Post Office Box 11296
Columbia, South Carolina 29211

Mr. Julian R. Harrison
Department of Biology
College of Charleston
Charleston, South Carolina 29424

Mr. Patrick D. McArthur
Department of Biology
Erskine College
Due West, South Carolina 29639

Mr. Alan Shoemaker
Riverbanks Zoology Park
Columbia, South Carolina 29210

Mr. Andy Boone
Post Office Box 21707
Columbia, South Carolina 29221

Mr. Gene Wood
Post Office Box 596
Georgetown, South Carolina 29442

Mr. Charlie W. Wooten
Department of Biological Science
Clemson University
Clemson, South Carolina 29631

Mr. Jim Fitzpatrick
105 Azalea Circle
Cayce, South Carolina 29033

Mr. Brian A. Locke
Department of Biology
New Mexico State University
Las Cruces, New Mexico 88003

Ms. Pam Skogg
Minnesota Department of Natural Resources
315 Charles Street, NW.
Brainerd, Minnesota 56401

Mr. Terry L. Sharpe
North Carolina Wildlife Resources Commission
317 Hamlet Avenue
Hamlet, North Carolina 28345

Mr. Gary A. Patterson
1209 Ridge Street
Naples, Florida 33940

Ms. Deb Jansen
Game and Fresh Water Fish Commission
3248 Kelly Road
Naples, Florida 33962

Mr. Roy DeLotelle
Environmental Science and Engineering
Post Office Box ESE
Gainesville, Florida 32602

Mr. J. H. Carter, III
Department of Zoology
North Carolina State University
Raleigh, North Carolina 27650

Mr. Ron R. Odum
Georgia Department of Natural Resources
Route 2, Box 119-A
Social Circle, Georgia 30279

Mr. Richard F. Harlow
Department of Forestry
Clemson University
Clemson, South Carolina 29631

Mr. Robert T. Stamps
Natural Resources Management Division
MCDEC
Quantico, Virginia 22134

Mr. Robert J. Blue
Shearon Center
Carolina Power and Light Company
New Hill, North Carolina 27562

Mr. Brian S. Barnett
Game and Fresh Water Fish Commission
Post Office Box 1840
Vero Beach, Florida 32960

Dr. Phillip D. Doerr
Department of Zoology
North Carolina State University
Raleigh, North Carolina 26750

Mr. Norman J. Lantz
North Carolina Wildlife Resources Commission
Route 1
Hoffman, North Carolina 28347

Mr. James C. Kroll
School of Forestry
Stephen F. Austin University
Nacogdoches, Texas 75962

Ms. Julie Hovis
4302 Northeast 17th Terrace
Gainesville, Florida 32601

Mr. J. R. Newman
Environmental Science and Engineering
Post Office Box ESE
Gainesville, Florida 32602

Mr. Richard R. Repasky
Department of Zoology
North Carolina State University
Raleigh, North Carolina 27650

Mr. D. Terry Gilbert
Game and Fresh Water Fish Commission
Post Office Box 1840
Vero Beach, Florida 32960

Ms. Barbara A. Harris
Department of Natural Resources
100 Eighth Avenue, SE.
St. Petersburg, Florida 33701

Ms. C. Barbara Brownsmith
415 SE. Sixth Terrace
Gainesville, Florida 32601

Mr. Gary L. Evink
Bureau of Environment
Florida Department of Transportation
605 Suwannee Street
Tallahassee, Florida 32304

Ms. Anne S. Wenner
Game and Fresh Water Fish Commission
4005 South Main Street
Gainesville, Florida 32601

Mr. Richard L. Thompson
U.S. Fish and Wildlife Service
227 N. Bronough Street, Suite 1022
Tallahassee, Florida 32301

Mr. Alexander Sprunt, IV
National Audubon Society
115 Indian Mound Trail
Tavernier, Florida 33070

Mr. Melvin L. Hopkins
Wildlife Staff
Supervisor Office
Kasatchie National Forest
2500 Shreveport Highway
Pineville, Louisiana 71360

Mr. Thad Cherry
Wildlife Research Supervisor
Weyerhauser Company
Post Office Box 1391
New Bern, North Carolina 28560

Mr. Ted Beckett
Magnolia Gardens
Route 4
Charleston, South Carolina 29407

Mr. Teddy E. Lynn, Jr.
International Paper Company
Georgetown Woodlands Region
Georgetown, South Carolina 29440

Mr. John E. Alcock
Regional Forester
1720 Peachtree Road, NW.
Atlanta, Georgia 30367

Regional Director (AFF)
U.S. Fish and Wildlife Service
Post Office Box 1306
Albuquerque, New Mexico 87103

Mr. Herb Kale
Florida Audubon Society
1101 Audubon Way
Maitland, Florida 32751

Mr. Martin E. Rivers
Director, of Environmental Quality
Room 201, Summerplace Building
Tennessee Valley Authority
Knoxville, Tennessee 37902

Regional Director
National Park Service
75 Spring Street, SW.
Atlanta, Georgia 30303

Dr. Jerome A. Jackson
Mississippi State University
Department of Zoology
Post Office Drawer Z
Mississippi State, Mississippi 32302

Mr. Daniel W. Lay
Texas Parks and Wildlife Department
Box 4608, SFA
Nacogdoches, Texas 75961

Mr. Randolph Perry
Endangered Wildlife Research
Patuxent Wildlife Research Center
Laurel, Maryland 20708

Lt. Colonel Jerry Hubbard
Director, Facilities Engineering
U.S. Army
Fort Stewart, Georgia 31314

Mr. Byron J. Farley, Forester
Attn: ATZB-FE
U.S. Army
Fort Benning, Georgia 31905

Mr. Jesse Horton, Forester
Attn: ATZN-FE
Fort McClellan, Alabama 36205

Mr. Robert Pouncey, Forester
Attn: ATZO-FE
U.S. Army Aviation Center
Fort Rucker, Alabama 36362

Lt. Colonel Ronald L. Bunch
Director, of Environmental Planning
Department of the Air Force
Headquarters Air Force Engineering
and Services Center
Tyndall Air Force Base, Florida 32403

Major General R. C. Marshall
Division Engineer
Department of the Army
Lower Mississippi Valley Division
Corps of Engineers
Vicksburg, Mississippi 39108

Mr. Dan M. Mauldin
Chief, Planning Division
Department of the Army South Atlantic
Division, Corps of Engineers
510 Title Building
30 Pryor Street, SW.
Atlanta, Georgia 30303

Mr. James A. Cox
Station Forester
Naval Weapons Station
Charleston, South Carolina 29408

Mr. Robert C. Beam
Real Estate Division
Department of the Navy
Atlantic Division
Naval Facilities Engineering Command
Norfolk, Virginia 23511

Mr. Howard N. Larsen
Regional Director
U.S. Fish and Wildlife Service
P.O. Box 129, Newton Town Branch
1 Gateway Center, Suite 700
Newton Corner, Massachusetts 02158

Mr. Don Bandel
Department of the Army
Army Natural Resources Office
DAE-MPO-B
Washington, D.C. 20314

Mr. Francis B. Roache
Director of Real Property Natural
Resources
Department of Defense
Pentagon, Washington D.C. 20301

Mr. Charles D. Kelley, Director
Division of Game and Fish
64 North Union Street
Montgomery, Alabama 36130

Mr. Steve N. Wilson, Director
Game and Fish Commission
2 Natural Resources Drive
Little Rock, Arkansas 72205

Colonel Robert M. Brantly
Executive Director
Game and Fresh Water Fish Commission
620 South Meridian Street
Tallahassee, Florida 32301

Mr. Leon A. Kirkland, Director
Game and Fish Division
270 Washington Street, SW.
Atlanta, Georgia 30334

Mr. Carl E. Kays, Commissioner
Department of Fish and Wildlife
Resources
1 Game Farm Road
Frankfort, Kentucky 40601

Mr. Lon Strong, Executive Director
Department of Wildlife Conservation
Post Office Box 451
Jackson, Mississippi 39205

Mr. W. Vernon Bevill, Executive Director
Wildlife Resources Commission
512 North Salisbury Street
Raleigh, North Carolina 27611

Mr. Jefferson Fuller, Jr., Director
Division of Wildlife and Fresh Water
Fisheries
Post Office Box 167
Columbia, South Carolina 29202

Mr. Gary Myers, Executive Director
Wildlife Resources Agency
Post Office Box 40747
Nashville, Tennessee 37204

Mr. Jack W. Raybourne
Chief, Game Division
Commission of Game and Inland Fisheries
Box 11104
Richmond, Virginia 23230

Mr. Charles D. Travis
Executive Director
Texas Parks and Wildlife Department
4200 Smith School Road
Austin, Texas 78744

Mr. Byron Moser
Chief, Game Division
Department of Wildlife Conservation
Post Office Box 53465
Oklahoma City, Oklahoma 73152

Mr. Ervin Bedker
U.S. Air Force
Chief, Natural Resources Office
Headquarters USAF/LEEV
Pentagon, Washington D.C. 20330

Ms. Mary Margaret Goodwin
Special Assistant for Environment
Office of the Deputy Under Secretary
of the Navy
Pentagon, Washington D.C. 20330

Mr. Jesse J. Guidry, Secretary
Department of Wildlife and Fisheries
400 Royal Street
New Orleans, Louisiana 70130

Mr. Ken Harris, Forester
Attn: AFZA-FE
U.S. Department of the Army
Fort Bragg, North Carolina 28308

Mr. George Lewis, Forester
B and G Division
Attn: ATZH-FE-B
Fort Gordon, Georgia 30905

Mr. Allen Brazell, Forester
Land Management Branch
Attn: ATZJ-FE
Fort Jackson, South Carolina 29207

Mr. Robert R. Pugh
Wildlife Resources Agency
Post Office Box 40747
Nashville, Tennessee 37204

Mr. Brandy Mannchen
Lone Star Chapter of the Sierra Club
1822 Richmond #2
Houston, Texas 77098

Mr. Robert G. Hooper
U.S. Forest Service
2730 Savannah Highway
Charleston, South Carolina 29407

Mr. Gene Namkoong
U.S. Forest Service
Box 7614
North Carolina State University
Raleigh, North Carolina 27695-7614

Mr. Bruce Stewart
Murray State College
Department of Science
Tishomingo, Oklahoma 73460

Mr. Jonathan Bart
Department of Zoology
Ohio State University
1735 Neil Avenue
Columbus, Ohio 43210-1293

Mr. Richard N. Conner, Ph.D.
U.S. Forest Service
Box 7600, SFA Station
Nacogdoches, Texas 75962

Mr. Edward C. Fritz, Chairman
Texas Committee on Natural Resources
5526 Dyer, Suite 111
Dallas, Texas 75206

Mr. J. David Ligon
University of New Mexico
Albuquerque, New Mexico 87131

Mr. Dean M. Simon
N-202 Rogers Road
Athens, Georgia 30609

Mr. Roger L. Davis, Director
Forestry Division
Department of Agriculture
2800 North Lincoln
Oklahoma City, Oklahoma 73105

Florida Audubon Society
1101 Audubon Way
Maitland, Florida 32751

Mr. Wilson W. Baker
Tall Timbers Research Station
Route 1, Box 112
Tallahassee, Florida 32302

Mr. Eugene Czuhai
U.S. Fish and Wildlife Service
Post Office Box 581
Washington, North Carolina 27889

Mr. Clyde A. Stewart
U.S. Fish and Wildlife Service
Post Office Box 187
Brownsville, Tennessee 38012

Ms. Ann E. Jerauld
806 NE. 11th Avenue
Gainesville, Florida 32601

Mr. Otto Florschutz
U.S. Fish and Wildlife Service
Post Office Box 581
Washington, D.C. 27889

Mr. D. J. Michael Sprott, Director
Cooperative Extension Service
Auburn University
Auburn, Alabama 36849

Mr. W. J. Moline, Director
Cooperative Extension Service
P.O. Box 391
Little Rock, Arkansas 72203

Mr. Shirley H. Phillips
Associate Director
Cooperative Extension Service
University of Kentucky
Lexington, Kentucky 40546

Dr. Denver T. Loupe, Director
Cooperative Extension Service
Louisiana State University
Baton Rouge, Louisiana 70803

Dr. James R. Carpenter, Director
Cooperative Extension Service
Mississippi State University
Mississippi State, Mississippi 39762

Dr. Chester D. Black, Director
Cooperative Extension Service
North Carolina State University
Raleigh, North Carolina 27650

Dr. Wayne T. O'Dell, Director
Cooperative Extension Service
Clemson University
Clemson, South Carolina 29631

Dr. Lloyd Downen, Dean
Cooperative Extension Service
P.O. Box 1071
Knoxville, Tennessee 37901

Dr. Zerle L. Carpenter, Director
Cooperative Extension Service
Texas A&M University
College Station, Texas 77843

Dr. M. R. Geasler, Director
Cooperative Extension Service
Virginia Polytechnic Institute and S.U.
Blacksburg, Virginia 24061

Mr. Edwin W. Waddell, State Forester
Arkansas Forestry Commission
P.O. Box 4523 Asher Station
Little Rock, Arkansas 72214

Dr. Tal C. DuVall, Director
Cooperative Extension Service
University of Georgia
Athens, Georgia 30602

Dr. John T. Woeste, Director
Cooperative Extension Service
1038 McCarthy Hall
University of Florida
Gainesville, Florida 32611

Mr. Robert S. Moss, State Forester
Mississippi Forestry Commission
908 Robert E. Lee Building
Jackson, Mississippi 39201

Mr. H.J. Green, Director
Division of Forest Resources
North Carolina Department of Natural
Resources and Community Development
Box 27687
Raleigh, North Carolina 27611

Mr. James W. Garner, Jr., State Forester
Virginia Division of Forestry
P.O. Box 3758
Charlottesville, Virginia 22903-0758

Mr. Roy C. Ashley, State Forester
Tennessee Division of Forestry
Department of Conservation
701 Broadway
Nashville, Tennessee 37203

Mr. Bruce R. Miles, Director
Texas Forest Service
Systems Administration Building
College Station, Texas 77843

M. Roger L. Davis, Director
Forestry Division
Department of Agriculture
2800 North Lincoln
Oklahoma City, Oklahoma 73105

Carolina Sandhills NWR, McBee, SC

Felsenthal NWR, Crossett, AR

Mattamuskeet NWR, Swanquarter, NC

Noxubee NWR, Brooksville, MS

Okefenokee NWR, Folkston, GA

Upper Ouachita NWR, Monroe, LA

Pee Dee NWR, Wadesboro, NC

Piedmont NWR, Round Oak, GA

Santee NWR, Summerton, SC

St. Marks NWR, St. Marks, FL